MAY 21 1917

VOL. LXXX. No. 2057. [All Rights Reserved.] APRIL 27, 1917. [Registered at G.P.O. as a Newspaper and Canadian Magazine rate of postage.] PRICE FOURPENCE.

LONDON: PUBLISHING OFFICE, 4, LUDGATE HILL, E.C. 4 SUBSCRIPTION per annum, Postage inclusive, in Great Britain, £1 1s. 8d.; Canada, £1 3s. 10d. ($5.80); to all other countries, 30s.—NEW YORK: D. VAN NOSTRAND CO., 25, Park Place, New York City. TORONTO, ONT.: WM. DAWSON & SONS, LTD., Manning Chambers. PARIS: BOUVEAU & CHEVILLET, Librairie, Etrangère, 22, Rue de la Banque.
Telegraphic Address: "Ageekay, London." A B C Code. Telephone Nos. City 997; Central 4425 (Editorial only).

MOULDED INSULATORS
Of all Descriptions.
LITHOLITE, Ltd.,
66-67, Hackney Grove, London, N.E.

AIR COMPRESSORS
& VAC. PUMPS,
Desiccators
Sets.
NORMAN DICKSON, PRINGLE & Co.
Cable
Pumps &
Impregnators.
25, Victoria St., Westminster.

WIRES.
THE GENERAL CABLE MANUFACTURING CO., LTD.,
Imperial House, Kingsway, London, W.C.
Phone: Regent 5781.
CABLES.

EVERY DESCRIPTION OF
SMALL TURNED PARTS and CASTINGS for ELECTRICAL ENGINEERS.
A. MORTON,
6, Tenby Street North, Birmingham.

BROOK
Single-, Two- and Three-Phase Motors
LONDON, LEEDS and HUDDERSFIELD.
See Advertisement Sup. 38.

SWITCHGEAR.
ERNEST F. MOY, LTD.,
Manufacturing Electrical Engineers and Government Contractors.
GREENLAND PLACE, CAMDEN TOWN, LONDON.

TAYLOR & CO.
MICA & MICANITE
Speciality:—Plates for high resistance.
TELEPHONE:—CENTRAL 4575.
40, HATTON GARDEN, LONDON, E.C.

Osram, Mazda, Wotan, "Z" and other Ring Lamps.
Pocket Lamps, Torches, Batteries, &c.
E. DAWSON & CO.
Late of KRUPKA & JACOBY, Ltd.
24, GRAY'S INN ROAD, London, W.C.
Telephone: HOLBORN 2794.

CHURTON
SINGLE and POLYPHASE
MOTORS.
T. HARDING CHURTON & CO., LTD.,
Atlas Works, Water Lane, LEEDS.

LIFTS and - - - TRANSPORTERS.
Wm. WADSWORTH & SONS, LTD.,
BOLTON.

"EMPIRE"
AUTOMATIC CONTROL
FOR
Shell Presses, Compressors, Machine Tools.
ELECTRIC CONTROL, LIMITED, GLASGOW.

WESTERN-ELECTRIC
COMPANY, LIMITED,
Norfolk House, Victoria Embankment, W.C.
Works: NORTH WOOLWICH, LONDON, E.
TELEPHONES & CABLES.
See Advertisement last week, Sup. 31.

CONNOLLY BROS., Ltd.,
for
WIRES AND CABLES.
See Advertisement this week, p. iii.

WHITE
Electrical Instrument Co.
2, 4, & 6, GLOUCESTER ST., CLERKENWELL, LONDON, E.C.
Wire: Voltograph, London. 'Phone: City, 8660.

LANGDON-DAVIES
ELECTRIC MOTORS.
One, Two and Three-Phase.
LANGDON-DAVIES MOTOR CO.,
110, Cannon Street, London, E.C.

INSULATING - - BEADS - -
Immediate Delivery.
HOLDER-HARRIDEN LTD., 35|37, Noble St., London, E.C.

CABLES AND WIRES.
SWITCHBOARDS.
TRANSFORMERS.
JOHNSON & PHILLIPS, LTD.,
CHARLTON, LONDON, S.E.

Better than Rubber, Leather and Gutta-Percha.
BELTING.
DERMATINE
DERMATINE CO., Ltd.,
Neate St., London, S.E. 5

LARGE STOCK KEPT FOR QUICK DELIVERY
SHUNT REGULATORS,
MOTOR STARTERS and all classes of Resistance Work.
The SOLENOID REGULATOR Co. (GEORGE A. YARWOOD Proprietor),
HIGHGATE SQUARE, CAMP HILL,
Telephone: Midland 582. BIRMINGHAM Telegrams: "Solenoid, Birmingham."

MAVOR & COULSON, Ltd.,
GLASGOW.
MOTORS, DYNAMOS, SWITCHGEAR.

STONE'S ELECTRICAL INSTALLATIONS for RAILWAY CARRIAGES.
50,000 COACHES EQUIPPED ALL OVER THE WORLD.
J STONE & COMPANY, Ltd.,
Deptford, London.

THERMIT, LIMITED,
675, COMMERCIAL ROAD,
LONDON, E.
'Phone: EAST 4157. 'Grams: "Fulmen, Step, London."
PATENT
Alumino Thermic Welding Process.

START LIGHT.
THE
WOODHOUSE AUTOMATIC CLUTCH
PICKS UP LOAD AFTER STARTING.
THE VICTORIA DYNAMO & MOTOR CO.,
CRAVEN HOUSE, KINGSWAY, W.C. 2

INGLEBY & CO., LTD.
ELLAND ROAD, LEEDS.
MOTORS
FOR DIRECT AND ALTERNATING CURRENT
Tel. 378
Delivery from Stock up to 50 H.P.

Advertisement Index, see page xxiv.

O.K.

DRY CELLS

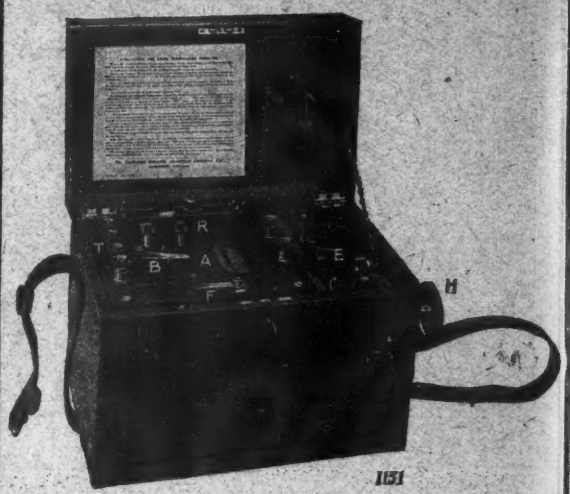
LARGE STOCKS AVAILABLE FOR IMMEDIATE DELIVERY.

THE EDISON SWAN ELECTRIC COMPANY, LIMITED,

PONDER'S END WORKS, MIDDLESEX.

'Phone: 520 ENFIELD.

A STANDARD PYROMETER

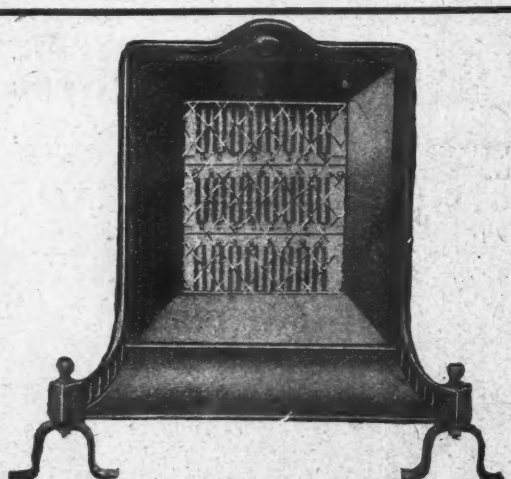


1151

A Whipple Temperature Indicator, as illustrated, used with a platinum resistance thermometer, forms a reliable standard pyrometer, by which other instruments can be checked. The scale is divided every degree from —10° to 1200° C.

For full description see List No. 196 V, sent free on request.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., Ltd., CAMBRIDGE - ENGLAND.



THE

ARORA ELECTRIC FIRE.

Has given universal satisfaction.

Low Price, Robust, Cheery, Economical.

NO Advance in Prices. DELIVERY from STOCK.

Write for List E (Fires & Cookers) to Sole Manufacturers :

THE ARORA CO., Loughborough.

(Proprietors: MESSENGER & Co., LTD.)

THE CHATTERAK

Replaces a Telephone Clerk.

Price 3/6 Post Free 3/9

Sold by Office Stationers and General Stores

THE CHATTERAK COMPANY
QUEEN ANNE'S CHAMBERS WESTMINSTER LONDON W

SELLING AGENTS WANTED.

VULCANISED FIBRE.

In Sheets, Rods, Tubes, and Special Shapes.

Horn Fibre, Diamond Insulation, Press Board, Fuller Board, &c.

DIAMOND FIBRE TRADE MARK

DIAMOND STATE FIBRE CO., 57, OLD ST., LONDON E.C.

THE
ELECTRICAL REVIEW.

VOL. LXXX. APRIL 27, 1917. No. 2,057.

ELECTRICAL REVIEW.

Vol. LXXX.] CONTENTS: April 27, 1917. [No. 2,057.

	Page
Reasonable Imagination	449
Electric Power on Canals	450
Wiring with Tough Rubber Compound Cables, by W. Ellerd-Styles (*illus.*)	451
Wayleaves	454
Machine-Switching Telephone Gear, by F. R. McBerty	454
The Telegraphic Communications of the Empire	457
The American Electrical Industry in Time of War	458
Correspondence—	
Fault Localisation	458
Electric Fires	458
Municipal Electrical Publicity	458
The I.E.E. Nominations	458
New Electrical Devices, Fittings and Plant (*illus.*)	459
The Training of Disabled Sailors and Soldiers for Electrical Sub-station Work	460
Legal	460
War Items	460
Business Notes	461
Notes	465
City Notes	467
Stocks and Shares	469
Market Quotations	470
The Importance of Canal Development to the Electrical Man, by W. T. Wardale	471
Voltage Regulation of Rotary Converters (*illus.*)	472
First London Engineer Volunteers	474
Novel Features in D.C. Watt-Hour-Meter Construction (*illus.*)	474
The Wiring Rules of the Institution of Electrical Engineers, by W. R. Rawlings	475
New Patents Applied for, 1917	476
Abstracts of Published Specifications	476
Contractors' Column	Advertisement page xx

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C. 4.

Telegraphic Address: "AGREEAY, LONDON." Code, A B C.

Telephone Nos.: City 997; Central 4425 (Editorial only).

The "Electrical Review" is the recognised medium of the Electrical Trades, and has by far the Largest Circulation of any Electrical Industrial Paper in Great Britain.

Subscription Rates.—Per annum, postage inclusive, in Great Britain, £1 1s. 6d.; Canada, £1 3s. 10d. ($5.80). To all other countries, £1 10s.

FOREIGN AGENTS:

ADELAIDE: Messrs. Atkinson & Co., Gresham Street.

AUCKLAND N.Z.: Gordon & Gotch, Albert Street; The Mining and Engineering Review, 31A, Strand Arcade, Queen Street.

BRISBANE: Gordon & Gotch, Queen St.

CHRISTCHURCH, N.Z.: Gordon and Gotch, Manchester Street.

DUNEDIN, N.Z.: Gordon & Gotch, Princes Street.

JOHANNESBURG, CAPETOWN, BLOEMFONTEIN, DURBAN, PORT ELIZABETH, &c.: Central News Agency, Ltd.

LAUNCESTON: Gordon & Gotch, Cimitiere Street.

MELBOURNE: The Mining & Engineering Review, 90, William Street; Gordon & Gotch, Queen Street.

MILAN: Fratelli Treves.

NEW YORK: D. Van Nostrand, 25, Park Place.

PARIS: Boyveau & Chevillet, 22, Rue de la Banque.

PERTH, W.A.: Gordon & Gotch, William Street.

ROME: Loescher & Co., Corso Umberto 1° 307.

SYDNEY: The Mining & Engineering Review, 273, George Street; Gordon and Gotch, Pitt Street.

TORONTO, ONT.: Wm. Dawson & Sons, Ltd., Manning Chambers; Gordon and Gotch, 132, Bay Street.

WELLINGTON, N.Z.: Gordon & Gotch, Cuba Street.

Cheques and Postal Orders (on Chief Office, London) to be made payable to THE ELECTRICAL REVIEW, and crossed "London City and Midland Bank, Newgate Street Branch."

THE "ELECTRICAL REVIEW'S"

ELECTRICAL & ALLIED TRADES DIRECTORY

(THE RED BOOK),

1917 EDITION

NOW READY.

H. ALABASTER, GATEHOUSE & KEMPE,

4, Ludgate Hill, London, E.C. 4.

REASONABLE IMAGINATION.

STATESMEN at Home, Colonial Premiers, lesser politicians, and hard-headed business men, are all appealing to us to exercise in these momentous times the gift of imagination. The quartette sounds well, is faultless in execution, is rendered at the psychological moment, therefore is most effective and quite rightly evokes thunderous applause. But what is this great gift that we are all urged to exercise? Are we all possessed of it? Do we know how to use it well? Unless we use it with discretion, may it not "run riot" and degenerate, as some writer of the past has said, into unrestrained enthusiasm which may be likened to a "runaway horse"? Suitably used, at a period of national emergency, it saw the dread possibilities of the prolonged war with Central Europe, and put under properly organised control, it led to the establishment of munitions manufacturing and ordering on such an immense scale that the cause for which Free Peoples are fighting to-day has been saved. This was real Statesmanship—the man for the hour was found in the person of the present Premier—a man of imagination and foresight *par excellence*. We organised our industries, our engineering and other resources, to secure the one great end. The appeal of the Colonial Premiers who are amongst us to-day summons us to bring our minds to bear upon other problems, less immediate perhaps, but problems supremely momentous for the days that may not be very far away. Sir Robert Borden weightily voiced the appeal at Manchester on Monday last. The British Empire is a vast heritage, free in certain respects to all of us—ours! But, says Sir Robert, and so we needs must recognise, it imposes corresponding responsibilities which we cannot fulfil unless we possess "the vision and the imagination to grasp its immense possibilities."

Then we come to the lesser politicians and the social reformers, and we find them all bowing in adoration before the same great power for good or evil, and urging that in our preparations for the strange ways of after-war along which our own and other nations will eventually have to pass—the stage of reconstruction—we be men of vision, of foresight, quick to read the signs even before they can take definite shape. They may be critical days for most of the world, and the appeal is not by any means unneeded. But now we turn to the last-mentioned of our quartette—the "hard-headed business man," as we have termed him, as represented by Mr. Dudley Docker, founder of the British Industries' Federation. Writing in an evening newspaper, he discusses that problem which

soon may be second to none in importance, though interconnected with the problems of the Colonial Premier, the lesser politician, and the social reformer—the new relationship of Capital and Labour. Mr. Docker says that our difficulties in the past were in a large measure attributable to "lack of imagination." Imagination is a quality essential to the success of any undertaking, "undertaking" including, of course, trade. "Lack of imagination renders one blind to the possibilities of a situation. It prevents an appreciation of another person's point of view, and it militates against any negotiations through want of understanding." Now, if there is anything we need to perceive to-day it is the possibilities of the situation. Events come tumbling so thickly and so fast that we have hardly recovered from one great transformation before we are in the midst of another. It is difficult enough to understand, sometimes, even the situation itself, if we take the near view, let alone its possibilities. Still, we have to face the situation, changing as it may be, with the utmost care, forethought, and, if we can, imagination. We may be on the verge of democracy's greatest plunge for liberty and freedom. Events in Russia, the incoming of the United States, the signs of socialistic struggling to cast off the yoke of militarism in Germany, may all be portents of immense efforts from the workers of the world for securing the future consideration of their interests. The workers of the British Empire have in millions paid their price to liberate the world from its oppressors. The time of their return will come. They, as well as statesmen, politicians, and hard-headed business men, will have the gift of imagination, and they will want to exercise it, too. Here, then, assuredly is a matter calling for men of imagination in industry to exercise their foresight in such a way that the imagination of Capital and Labour may not come into collision in the pursuit of their ideals. Compared with the pre-war conditions, it is something great to have arrived to-day at that stage toward industrial harmony where, as Mr. Dudley Docker says, "representative employers and trade unionists have agreed *to look at* each other without the intervention of Government or politician," and have founded the National Alliance of Employers and Employed. They have *looked at* each other in the past—with drawn daggers, but the employer who will grind all that he can out of his workpeople, and will not consider their "welfare" along the lines that have proved humane and successful during war, can have no self-respecting *rôle* to fill in our future industrial economy. We doubt whether many of his cult remain to-day. Nor will there be self-respect or peace for any of us if Labour utters again its pre-war threats and hates, and throttles progress by its short-sighted obstructiveness and limitation. Imagination, discreetly guided, counselled by experience, not imagination run riot and degenerating into the enthusiasm for ideals which will liken it to a "runaway horse," will be as necessary a quality for Labour as for Capital, and any step that will lead us into that spirit of industrial peace, that co-partnership in industry which will enable us to live in prosperity and real freedom and happiness for years to come is to be most cordially welcomed. The new National Alliance is undoubtedly a move in the right direction. As Mr. Docker says: "Many old shibboleths have disappeared, and all that is wanted is the exercise of *reasonable* imagination and human sympathy." He holds that the success of the new Alliance will be assured if each member will endeavour to understand the point of view of his neighbour. That is no easy matter, but the way to arrive at it is to look a little beyond our own immediate personal fads and fancies, predilections and objections; and imagination and a far-off look are more essential than the immediate counting of our individual rights and possessions, and than the refusal to consider the claims of others to be entitled to a share therein. It will be useless talking Industrial Peace, Industrial Harmony, and so on, unless men find that such conditions are going to clothe and feed those who depend upon them. Prosperity and good wages, considerate treatment and humane environment, are the only way to Industrial Harmony which will last. It ought not to require much imagination to *see* that, but a great deal of it will be required in the formulation of measures and the forming of an atmosphere by and in which that end is to be secured. The statesmen, the Colonial resources, the social reformer, and the hard-headed man of business, are the great co-operating means or forces or mediums through which we shall succeed. Appealing, as our leaders are, to others for the exercise of the gift of imagination, they will surely not neglect to exercise that gift themselves.

Electric Power on Canals.

An article which appears elsewhere in this issue directs attention once more to the immediate bearing of the canal question in this country upon the future of the electrical industry. As the author points out, the subject is intimately connected not only with the utilisation of electrical power on the canals themselves, but also with the supply and distribution of electricity in the districts traversed by the canals. As in the case of the electrification of the railways, the consumption of energy for haulage would provide a steady load from the commencement, and would thus remove one of the greatest obstacles to the wide extension of electric mains; the subsidiary demands for electricity could then be cultivated at leisure, and the advantages of electric power could readily be demonstrated to farmers and other prospective consumers in the neighbourhood of the waterways, while factories on the route could be supplied with lighting, power, and shipping facilities at one stroke.

In this connection, it is interesting to note that Germany is contemplating the construction of a great new waterway from Aschaffenburg to the Austrian frontier. Some details were given in the *Times* of March 1st, which states that the work involves the connection of the Main and the Danube, which rivers will also form part of the waterway; the total length of route will be 460 miles, and the aggregate cost is estimated at 32½ millions sterling, requiring an annual traffic of 10 million tons to cover the expenditure. A Bill authorising the outlay of £50,000 has been passed by the Bavarian Diet, this being the first instalment of a sum of £250,000 required to complete the plans for the new waterway. The canal is intended to accommodate ships of 1,200 tons, and will provide a connection between the North Sea and the Black Sea. A canal joining the Main and the Danube already exists, but can carry barges of not more than 125 tons, and is found to be wholly inadequate to meet the present demands. The scheme is only one of several projects of similar type, which illustrate the importance attached to the provision of internal water transit by Germany. Granting that the conditions there are far more favourable to canal development than in this country, the facts nevertheless indicate the economic value of such waterways, and warrant us in urging that the question should not be lost sight of.

WIRING WITH TOUGH RUBBER COMPOUND CABLES.

By W. ELLERD-STYLES, A.M.I.E.E., Member Electrical Contractors' Association (Incor.)

The following article has been written for the benefit of contractors and others interested in electrical installation work who may desire to erect tough rubber compound cables (popularly known as C.T.S.) in place of conduit, capping and casing, Stannos, Henley, or other system of wiring, several of which are restricted in application by the I.E.E. Rules issued in March, 1916. These Rules permit the use of tough rubber compound cables (C.T.S.), and, in view of this fact, the experience of the writer in the use of this class of cable in various situations may be of assistance.

Several contractors have doubted the claims of manufacturers of this class of cable as to its being suitable for users in all situations, and with a view to dispelling these doubts it can be stated that the covering possesses a remarkable degree of durability, there is no creeping of moisture into the insulation, it is immune from the usual chemical actions met with in practice, it possesses high resiliency, great tensile strength, and is difficult to injure by mechanical means. It is most easily installed, economical as regards labour costs and amount of material used, and entirely removes the trouble of earths, always ensuring a good insulation test. For surface wiring it easily scores over the metallic systems, being more flexible and unkinkable (a word adopted to convey the absence of kinks in the sheathing during the handling and erecting). An important detail is that it is popular with workmen who have made its acquaintance.

Dealing with tough rubber compound protection in his paper, "Wiring Rules of the Institution of Electrical Engineers," read before the Association of Supervising Electricians, Mr. W. R. Rawlings says: "It has been thought by many that the Institution should not allow this material to be used without protection." Why not? It has a protective sheathing. Several individuals have asked: If this class of cable is permitted, why should not vulcanised rubber cable of standard manufacture be used? The question is the outcome of inability to grasp the details of relative construction, and also the result of want of experience with C.T.S.

To begin with, the cables are insulated exactly in the same way up to the vulcanised layer. The ordinary V.R. cable is then finished with tape and braiding, both very hygroscopic, both very inflammable, and the red braiding in particular being appetising for mice and similar vermin. C.T.S., on the other hand, is finished with a protective coating of tough rubber compound (not, as some folk state, with ordinary rubber). This compound is non-hygroscopic, is not easily ignited, and vermin ignore it.

As to the question of fire risk, this should be sufficiently answered by mentioning the extensive use of C.T.S. cable for trailing cables, &c., in mines, and those individuals who hesitate to become converts to the use of this class of cable, and who lament the fact that it is permitted by the Rules, should attempt to gain some experience in mines and the severe conditions existing therein, and they would then see the cable question in its broadest aspect.

Metal-sheathed systems as a whole have the serious drawback of being subject to damage during erecting. The workmen have to use extreme caution in handling the material, an accidental blow with a hammer is fatal, and earth risks are to be considered. The open ends of the cable do not receive proper attention as regards sealing, with resultant trouble.

The question of lowering wiring costs is ever recurring, and many engineers are in favour of the Continental system, or the cleat system, as being within the region of cheapness; their opinion is that the appearance does not count. Perhaps not in factories, workshops, sheds, &c.; but what of the house, showroom, and better-finished establishments? It is easy to appreciate such disregard of artistic effects where the Huns are concerned, but it is not—British. Even in the poor man's cottage we find humble ornaments and decorations; do not let us abuse such places with what are apparently considered "improvements," but really constitute a "clumsy abuse."

Such a method of wiring as herein described could be classed as being the cheapest to install if the cable makers (a big "IF," please) would condescend to reduce their prices for this C.T.S. cable. A prominent cable-maker informed the writer that they *could* afford to lower prices. The labour costs are extremely low, and with the co-operation of the cable makers we should obtain a very cheap and reliable method of wiring which would rapidly popularise the use of electricity in directions at present monopolised by "penny slot meters."

To begin with it may be necessary to educate the supply authorities' representatives, also the prospective client, in the virtues and merits of this particular cable, as three following incidents demonstrate:—

1. On the completion of the electrical equipment of a large suburban residence, the supply authority's representative called to test and connect up. After the test, an inspection was carried out, and we were instructed to *earth* the sheathing. Of course, explanations followed.

2. Some large garage premises were being wired, consisting of several detached buildings, when the inspector observed that at several points the cable rested on girders and other ironwork. He gave instructions for insulating material to be placed between the cable and the metal work so as to avoid the risk of the sheathing being *earthed at these points.*

3. An incident of a different nature occurred at a residence during the wiring of the same for lighting and heating. The owner paid a visit, and observed that cables were being laid under the floors. He promptly 'phoned the supply authorities, stating that the electricians were using a *very funny stuff* for the electrical work. A representative

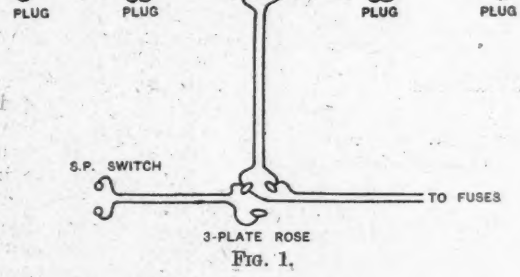


FIG. 1.

called, cut off a sample to test, and, after looking up the Rules, approved of its use. On the same job we arrived one morning to find notices chalked over the floors and walls, "Do not proceed—this must be in conduit." The sinking of the cable in the plaster disturbed the proprietor, so we explained that experiments had been carried out to determine the effects of "serapite plaster" on the covering; after a lengthy period, there was no adhesion of the plaster, and when the cable was chiselled out an insulation test proved it to be quite unaffected.

The above incident closed with a satisfied client, who is very pleased with his equipment.

It is not necessary to describe the corrosion-proof fittings (White's patents) manufactured by the St. Helens Cable & Rubber Co., of Warrington, for use with C.T.S. cables, as many booklets and pamphlets exist to assist in the erection of the system,* but we may show how to wire installations with ordinary accessories as used for house lighting and similar situations, including standard pattern distribution boards, wood blocks, ceiling roses, &c.

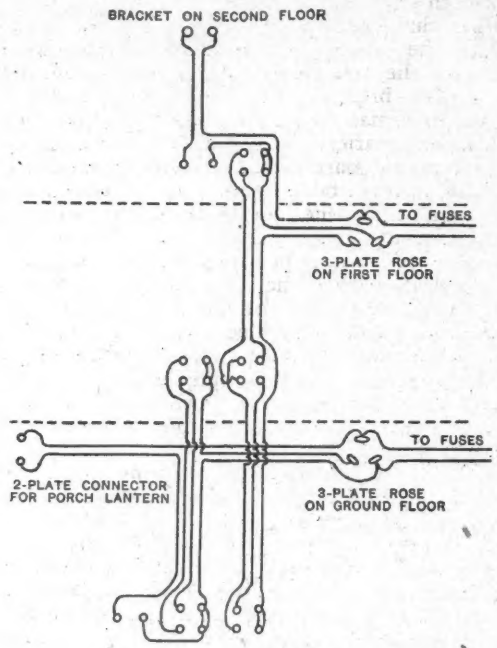


Fig. 2.—Vertical Wiring Diagram for Porch, Hall, and Stairs.

For wiring simply, the accessories, apart from the cable, are clips with suitable fixing pins.

The writer favours the use of flat section cable where the system is not required to be watertight, as it gives a better appearance than the circular core cable when used for surface wiring. The twin and three-core is useful for most runs, but for some situations it is advisable to use the single core, this

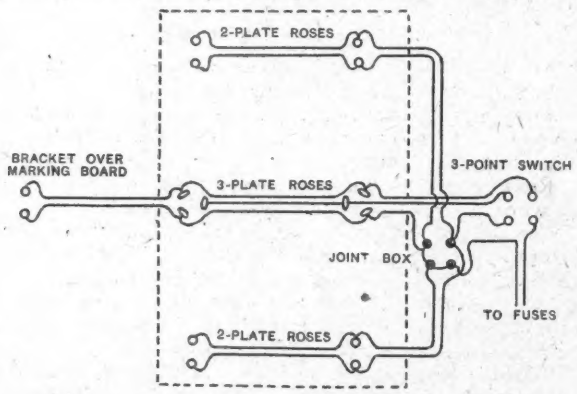


Fig. 3.

being a matter for the individual to decide who is responsible for the work. An advantage to be gained by using twin cable to the distribution board is that the time taken to sort out the circuits is reduced to a minimum.

A waterproof system is obtainable by using ordinary screwed surface boxes and outlets, as made for ½-in. conduit, adapted by the employment of externally screwed grip nipples. The circular section multicore cable is used, and stout rubber rings effectively bind the cable in the nipples.

When commencing an installation it is advisable to plot out the runs on a rough plan, and then arrange the circuits so as to make all runs as short as possible. Endeavour to arrange for suitable ceiling-plate connectors, and, if convenient, use C.T.S. junction boxes.

If concealed wiring is specified, it is necessary with walls of brick faced with plaster to chase out a narrow channel in the plaster to receive the cables, which will terminate in sunk boxes for the switches, using "serapite plaster" for making good. If the walls are of lath and plaster the wiring becomes extremely simple, a "fish wire" or "mouse"

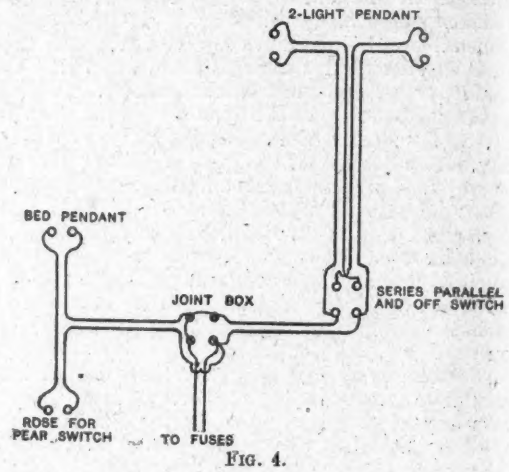


Fig. 4.

being employed to get the cable to the switch points.

The diagrams given show where multiplate ceiling roses and junction boxes can be used with advantage, and will assist in deciding what is advantageous when plotting out the work with a view to economising both material and labour, the ceiling roses serving as junctions for the cables, in addition to carrying the pendants. Looping-in is dispensed with to a considerable extent, resulting in a great saving of cable, &c.

Mr. D. S. Munro in his book, "The Practice of Electric Wiring," mentions that "Within recent years he has been in charge of a number of installa-

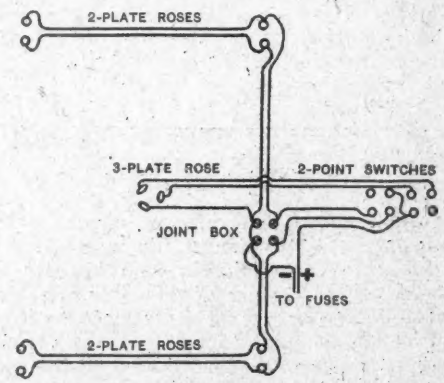


Fig. 5.

tions in which looping has been insisted on throughout. On the average house, with eight circuits feeding the usual 5, 3, 2, and single-light positions, he has found that quite 50 per cent. (in some cases 70 per cent.) additional cable is required for looping."

This adds unnecessarily to the cost; in addition, we have to remember that every unnecessary yard

* See also Electrical Review, February 5th, 12th, and 19th, 1915; November 19th, 1915; and February 2nd, 1917. —Eds.

of wire fitted is a disadvantage to the installation, one reason being that the best of cables have an average characteristic leakage per yard, and, therefore, increase in length must increase the total leakage, other things remaining equal.

The diagrams and controls given are those employed on a large suburban house recently completed. It is not claimed that the general arrangement of lighting, &c., is ideal, as, in common with this class of work, the client was guided partly by his architect and partly by his personal fads; nevertheless, this installation when completed possessed many advantages over the "cut and dried" method of wiring usually employed. To use a group of single-pole tumbler switches for controlling a cluster of lamps may look imposing to some folks, but it is really clumsy and unsightly, and a sign of ignorance, if not of present-day capabilities, at least of modern switches.*

Regarding the switch controls, it is necessary to mention that the switches used were partly of Messrs. A. P. Lundberg & Sons' manufacture, and the remainder were "Diamond H" switches. Flush patterns were specified in most situations, and in the less important rooms the surface pattern.

At both the South-Western Polytechnic Institute and the East Ham Technical College the students (ages 16-60) are given every facility for studying improved switch controls as part of the course of "Electrical Installation Work," and contractors generally would soon discover that they had a lot to learn in this direction if they cared to take the trouble.

It is not intended to give diagrams of the whole installation, as a good deal of repetition would occur; nevertheless, it is hoped that a study of those given will enable the prospective user of the C.T.S.

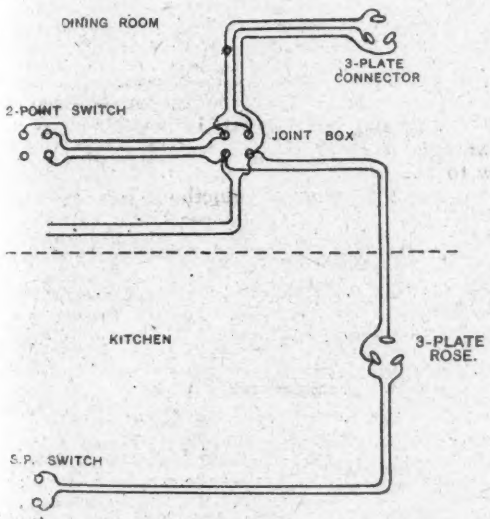


Fig. 6.

cables to proceed in an economical manner. Only the terminals of the accessories are shown.

Fig. 1 is extremely simple, and is intended to convey to the reader how easily a few switch plugs can be wired, and also the method of using a three-plate ceiling rose to avoid a loop into the switch, which may save several yards of cable. Twin cable is used for all the wiring shown.

Fig. 2 shows the controls for porch, hall, and landings, the pendants on the landings illuminating the staircase. In the hall are three sunk switches with an ornamental switch plate, namely, one single-pole and two two-way switches. On the first landing two sunk switches are fitted, a two-way and a two-way intermediate, while on the top landing there are a two-way and a single-pole switch. The hall pendant is controlled both from the hall and the first landing. The pendant on the first floor is controlled from three positions: hall, first landing, and second landing. The single-pole switch in the hall controls the porch lamp, and the single-pole switch on the second landing is for a bracket on that landing. Twin and single cables are employed for these circuits.

The billiard room circuit is shown in fig. 3. The switch is a "Diamond H" flush type three-point switch. The table pendants are wired in two sections; the centre pair are taken to one switch point, and the remaining four to another switch point. The bracket over the marking board is wired to the remaining switch point. We then have the following variety of controls: marking board alone, marking board with two table lights, marking board with six table lights, "off"; mostly twin cable used, with one length of triple and two lengths of single.

The diagram shown in fig. 4 is for a bedroom having a pendant over the bed controlled by a pear switch, and a two-light rise and fall pendant over the dressing table controlled by a "Lundberg" series-parallel and off switch. We therefore obtain three degrees of light: One lamp alone "full on" or off, two lamps "full on," two lamps in series "dim" and off; mostly twin cable, bedlight with single cable.

Fig. 5 is a diagram of the drawing-room controlled by "Diamond H" two-point flush pattern switches. The two pairs of corner lights are on one switch, and the centre three-light pendant is on the other switch. One switch gives 2—4—2 and off, the other switch gives 1—3—2 and off, this latter being the same as in the morning room. It will be seen that with the two drawing-room switches any number of lamps may be switched on from one to seven in steps of one.

Fig. 6 illustrates the wiring for dining-room and kitchen, and again demonstrates where a three-plate ceiling rose saves a long loop wire to the switch. The runs are exceptionally easy. A twin cable feeds the joint box from the distribution board. Another twin cable is taken from the joint box to the three-plate rose, looped-in to the terminals, and is then continued to the switch. For the dining-room a triple cable is taken from switch to joint box, then away to three-plate fixture block.

A Few Points in Conclusion.

Always continue the sheathing well inside of distribution boards, switch blocks, &c.

For surface runs, mark out the lines with chalk or pencil so as to assure symmetry, and space the clips at regular intervals.

Remember that cable is heavy, and it is easier to work the runs in a downward direction.

For surface work use uniform cable; for instance, if five wires are needed, do not run a triple and a twin, or two twins and a single, but five singles.

If a number of cables run side by side, do not use a number of clips side by side on each of the cables, but span them with a suitable saddle.

There is no braiding to bother with or to cause surface leakage, and no earthing troubles. There is no threading of conduit or capping and casing between partition walls.

You may continue your cables into exposed situations without fear of troublesome after-effects.

You are able to run cables in positions that would be impossible with other systems of wiring.

The extra cost of cable is more than compensated for by the saving in labour costs and shorter runs.

The writer has no interest in the above cable other than that of a satisfied user.

* For a good guide to switching see the booklet, entitled "Lektrik Lighting Connections," published by Messrs. A. P. Lundberg & Sons.

WAYLEAVES.

Mr. C. Vernier's paper was read and discussed at a meeting of the Newcastle Local Section of the Institution of Electrical Engineers on April 16th.

The Chairman (Mr. H. W. Clothier) said the present was an excellent time to tackle such a matter; these were times when they should get their troubles straightened out. Electricity in the past had been too much dominated by persons who did not understand it. The war had afforded a great opportunity to show its worth, and it had shown what it could do. When the nation realised its importance from a national standpoint, some of their difficulties would begin to disappear. Municipal representatives did not appreciate the public interests involved in electricity as they might do, and there was undoubtedly a tendency to look at any industrial concern that was pushing on as something that ought not to have the support of the general community. This difficulty, which was largely due to ignorance, could be removed by putting the proper men in the right place.

Mr. W. S. Burton (a local solicitor interested in electrical concerns) said that the opposition of some landowners to wayleaves was the real trouble; a landowner might say he would have nothing to do with wayleaves, and he was quite within his rights in saying so. The way in which this difficulty had been got over in that district was remarkable; of course, there had been delay, but the marvel was that there had been so few refusals. Mr. Vernier had restricted himself to agricultural and open lands; in dealing with such lands as parks they must admit that overhead wires and poles were not beautiful, and if they got such a system across a park, it did detract from the letting value of the mansion house. Instances of that kind were few, but the company would have to pay more for such depreciation. He thought the time had come when compulsory powers for the acquisition of wayleaves for electrical purposes were really necessary. He referred at length to the costliness of arbitration, and suggested that probably the best persons to act might be the local valuers appointed under the Land Valuation Department.

Mr. Crisp said the difficulty in negotiating wayleaves in that district was the question of delay, and it seemed iniquitous that one person should have it in his power to hold up some operations for, perhaps, 18 months. In regard to rental, it was not usually the large landowner who was difficult to deal with, but the small one. If some such measure as was suggested was not put into force, the working of many undertakings would be seriously affected.

Mr. Baldwin was not quite sure that compulsion would remove all the difficulties, but there was no doubt that great advantages would accrue from a measure such as that mentioned by Mr. Vernier. As to unreasonable terms demanded for wayleaves, he mentioned one case in which the owner stipulated that the poles should be painted red, white, and blue, with a pulley at the top so that the owner might raise the national ensign when he desired. Those terms were agreed to, and carried into effect. The landowner was perfectly satisfied; but in a few weeks' time he was certified as a lunatic.

Mr. Laws thought that seeing that wayleaves were essential they ought to be put on some ground of logic and equity. It was a matter in which there should not be any haggling. There were few men who would say that the rights of the individual should not give way to the interests of the community.

Messrs. Marshall, Turnbull, Elder, and Hunt also took part in the discussion.

MACHINE-SWITCHING TELEPHONE GEAR.

By F. R. McBERTY, M.I.E.E.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

(*Concluded from page* 400.)

The formulas for computing chances permit the calculation of a switching capacity at the various trunk links and switching machines which will be adequate for all but a certain peak of load, consisting in calls delayed, or blocked, by a busy-back signal. The cost of accommodating the peak may be considerable.

In a switching system in which the testing of trunks at a given group is not prolonged or repeated, an advancing connection which encounters all trunks busy is blocked and lost. When registers are employed for recording the number wanted and governing the selection and the testing of trunks, the test of engaged trunks may be prolonged or repeated until a trunk becomes available; the call is then merely subjected to a delay which is negligible in the time of total completion. The table below shows for a system constructed for the repeated testing of busy trunk groups, and for the switching machines of a single group employed at four different percentage efficiencies, the percentage of busy hour calls which would wait longer than 12 seconds. In a machine-switching equipment with such registers, it was found by test that the number of final switches could be reduced to the extent of 25 per cent. before the delays imposed upon connections in progress because of repeated testing to obtain an idle line switch became perceptible to the users.

Percentage of Calls Lost or Delayed.

Efficiency p.c.	Calls lost on test p.c.	Calls waiting longer than 12 secs. p.c.
0.55	3.4	0.45
0.65	8.3	1.4
0.70	12.2	3.8
0.80	23.4	9.0

Since the switching capacity of the system affects the cost of the equipment to a very considerable degree, it would seem highly desirable that a standard method of computing the switching machines in an equipment should be agreed upon as a basis of "rating" or comparing systems of different types.

Controlling the Switches.

The manner of controlling the movements of the two types of switches with ratchet and power motors are characteristically different; the ratchet motor impulses of current are produced by the controlling means which operate the motor magnets of the switches successively step-by-step, advancing the moving member to an extent corresponding to the number of impulses; in the power-driven switch, the switch is set in motion, and in its motion transmits back to the controlling means impulses of current which measure the progress of the switch and enable the controlling means to stop it when the desired displacement has been produced.

The control of the switching machines may be exercised either by the subscriber himself, furnished with a number-transmitting dial, or by an operator acting under the subscriber's direction by telephone.

When the manual switch-controlling mechanism is located at the central office it takes the form of keys corresponding to the numbers like those of a typewriter, which can be manipulated with great facility and accuracy. To transmit a five-digit number by means of a dial sender requires about six seconds; to set up a like number on keys requires no more than one second. In several semi-automatic switching systems the keys directly govern the impulses distributed to the switching machines. Since the operator can dispose of connections more rapidly than the switching machines can perform the numerical and junction selections, two or more sets of keys are furnished for each operator which she may use in succession. In the system of the offices G, I, J, and K, and others later referred to, a single set of keys placed before the operator is associated with several sets of numerical registers, any of which may be set to position corresponding with the numbers of the keys depressed; and the registers free themselves when set from the keys and remain associated with the machines until they have guided the latter to the indicated connections.

These registers are of the same general nature and govern the switching machines in the same way whether they are set to position by means of the keys of the operator, or by means of the number-transmitting dial at the subscriber's station.

Operating the registers or switching machines directly from the subscriber's station very little affects the nature of the central office switching mechanism; the control of the machines by operators, however, considerably modifies both the machine-switching equipment and the work of operators in comparison with manual switching.

Call Distribution to Semi-automatic Operators.

The use of seeking machines, whether pre-selectors or finders, for concentrating the incoming calls upon the group-choosing switches, in semi-automatic operating, permits at the same time a concentration of the work of answering, establishing, and supervising connections upon a minimum number of operators, and the equable distribution of the work amongst them. In machine switching, the same mechanism collects the calls from a large number of lines, concentrates them upon a limited number of trunk circuits, and brings them before a limited number of operators in charge of those trunk circuits. The trunks ending in seeking switches are occupied for the full holding time of a connection, and hence must be available in a relatively large proportion to the calling lines.

It is profitable to concentrate the incoming calls upon an operator up to her full capacity, which may be about five or six hundred connections per hour. A condition limiting the load is the delay imposed upon the individual subscriber's call before it receives attention, which can be kept down only by reducing the load on the operator and so increasing the wage cost per connection, or by distributing calls to a larger number of operators and thereby increasing the quantity of distributing machinery. The aim of good manual practice is to answer the calling subscriber in an average time of 3½ seconds, with no more than 5 per cent. of the calls delayed more than 10 seconds.

The operator's delay in answering a call on a manual switchboard is composed of two factors, of which the first is a nearly fixed minimum time of rather more than two seconds for observing the call signals, plugging into the calling line,

and connecting her telephone; while the other is the wait imposed while the operator serves other calls, which increases with increasing load.

A high grade of service can be attained consistently with a high load upon each operator, by providing for connecting any call originating amongst two or three thousand lines with any of six or more operators. To perform such a distribution requires seeking switches of large switching capacity.

The results of the foregoing studies and conclusions have been embodied in a number of machine-switching plants, of which one—a semi-automatic equipment for an exchange area in France—is described in some detail in the paper.

The office in question is the centre of an important toll traffic which is provided for in the usual manual toll and recording positions. The switching of calls from lines demanding toll connections and of calls for lines of the automatic equipment is performed by machine switches.

The exchange equipment is in the single large office of the area; conversion of the area to automatic working takes place completely with the cutting over of the office. When the machine-switching equipment is in one office of a multi-office area, special provision is required for passing calls from the manual to the automatic equipment, and from the automatic to manual equipments, without impairing the telephonic service or reducing the efficiency of operation of the automatic equipment.

For receiving traffic from a manual office to lines in a machine-switching equipment, semi-automatic positions are furnished in which the junctions terminate from the manual office. The operator, upon receiving an order for a wanted party in the automatic office, selects an idle junction in her position, designates it by number to the ordering operator (who plugs into it at the outgoing end) and depresses the keys of the number called for. The registers take the positions corresponding with the number ordered, release the numerical keys, and perform the mechanical selection of the wanted line. Supervision remains in the manual board as usual. Disconnection takes place automatically when the plug is withdrawn at the outgoing terminal of the junction in the manual board.

The service at the incoming semi-automatic terminal of the junction is surprisingly accurate and prompt; the calls are disposed of with such swiftness as to reduce the drag of the "B" operator upon the "A" operator while permitting the carrying of a substantially increased load by the "B" operator.

Passing traffic from a machine-switching office (whether semi-automatic or full-automatic) to a manual office is performed with the aid of a number-indicating device before the incoming junction operator in the manual office, which reproduces before the operator visually the number stored in the registers by the semi-automatic operator or by the subscriber.

Telephone Service in Machine-switching Systems.

The benefits derivable from the substitution of machines for operators and manual-switching apparatus are of three principal sorts: improvements in service, economies, and freedom in development.

The user of the telephone is interested in the accuracy and promptness with which switching is performed, and in the constant availability of his individual equipment, and he obtains, from machine switching, gains in these particulars which are definite and substantial. In manual switchboards, the errors in switching may range from a minimum of about 2.5 per cent. to above 5 per cent., dependent on whether junction-working is involved. In machine-switching systems they may be brought readily to a daily average of 1 per cent., and in certain equipments have ranged about 0.25 per cent. and as low as 0.1 per cent. In semi-automatic operating, the operator easily attains the same skill in manipulating keys as in typing, and her errors become negligible. A mechanical equipment in good order will perform thousands of selections without error. Both sources of error are independent of junction working.

The promptness of switching in the full automatic system leaves little to be desired by the user. The ringing of the bell at the wanted station begins practically as soon as the calling party completes dialling the number. In systems with operators, the delay which ordinarily impresses the subscriber is that in reaching the operator to give his number, and the quality of service is judged by the percentage of occasional long delays, as well as by the average time of response. The standard for service in manual exchanges generally accepted has already been referred to—the average response for the number is 3.5 seconds after the subscriber takes the telephone, with no more than 5 per cent. delays exceeding 10 seconds.

The table shows the times for answers measured from taking the telephone (or calling) to the answering operator's response:—

Answering Time, Average.

	Seconds.
Manual central battery, standard	3.5
Manual central battery, heavy load, "M"	4.5
Semi-automatic system, "I"	2.1
Semi-automatic system, "J"	2.2

Another measure is the time from initiating the call to the beginning of ringing the bell at the wanted station. Within this period there is no delay which is not directly dependent upon the operator and the apparatus except the drag of the subscriber in giving his order, which ordinarily is not a large factor.

Time from Initiating Call to Ringing Bell of called Station.

	Secs. (aver.)
Manual C.B. exchange, "M," best performance ...	10.3
Manual C.B. exchange, "M," heavy load	12
Manual C.B., 100 per cent. junction calls	18.5
Semi-automatic, "I"	10.3
Semi-automatic, "J"	10.5
Full automatic, "H"	8.5

Data for direct comparison of the time of connecting for the same subscribers' lines by manual and by machine switches are at hand for only one office, "I," located in France. The replaced equipment was a magneto board; the replacing equipment a Western Electric semi-automatic machine system. The measured times run from the moment of the operator's answer—the insertion of the plug in the one case, the passing of the call to the telephone in the other—to the beginning of ringing. In the machine equipment, the average time is about half that formerly experienced, and 95 per cent. of the connections are made in one-fourth the former time, the maximum time being only one-fifth of the former maximum.

The shorter time noted in the above table for the full automatic system is due to the omission of the time waiting for the operator. Otherwise the time for getting connection in a self-contained office is not largely different in manual and in machine-switching systems. In multi-office areas, however, with a considerable percentage of junction calls, working through second operators adds largely to the time occupied in manual switching, but adds nothing to that in machine switching.

The "cut-offs" in manual boards are well known to be due to the accidental withdrawing of plugs; no corresponding interference takes place in the mechanical equipments. Connections to wrong lines are common in large multiples by reason of indistinct or effaced numbering, or of error in choosing the jack at arm's reach. Double connections result from simultaneous plugging in or from defect in or failure to recognise the busy test. Neither of these faults has developed in any of the exchanges of types "I" and "J"—some tens of thousands of tests have failed to produce double connections. Connections made by the "B" operator to the wrong lines are in part due to errors in passing the number. Errors and faults corresponding to those of the "B" operator are not found in machine-switching equipments.

A third improvement in service of marked value, but obscure origin, is that before referred to as an increase in the availability of the subscribers' lines. The duration of a connection is noticeably less in machine-switching systems.

The more obvious economies offered by machine switching are in operating and supervising forces and in plant. The possible net savings in operating are still subjects of controversy, which, however, is in a fair way to settlement by reason of the increasing volume of reliable data; while the savings in plant which might be made are still somewhat speculative, no complete development plan having been carried out wholly on the most promising arrangements permitted by the use of machine switches and distant control.

The range of variation in wages, loads, and relief forces for operators, and in first costs, maintenance costs, and depreciation of machines, is such that a judicious choice of factors permits a demonstration of either gain or loss in replacing manual by mechanical switching. As the range is narrowed by reasonable assumption and practical experience, however, the case seems to be made out with increasing margin for the machine switch.

The handling time of the operator per connection is a very significant, though not an entirely satisfactory, measure of probable operator's loads and costs of operating, for the reason that it is definitely measurable and comparable in different systems.

An operator at a manual central-battery board with no trunking can give fairly prompt service without undue fatigue under a load of 230 calls per busy hour, and can carry a load of 400 calls with exceptional fatigue and a notable impairment of service. Such an operator can give more prompt service with ease through a mechanical switching system under a load of 450 or more busy hour calls of like average character, and can carry 600 or even 700 calls in exceptional cases without noticeable impairment of service or troublesome fatigue. Junction calls reduce the load materially in manual systems, but not at all in mechanical switching.

Maintenance of Machine Switches.

As in the earlier history of the conversion of central office equipment from the magneto to the central-battery system, so in the conversion of central battery to machine-switching systems, the difficulties and expenditures actually experienced turn out to be less important than anticipated, and show a substantial diminution as the result of progressive improvement in manufacture and in practice. The early automatic exchanges required the attention of men in such numbers and of such skill to keep the equipments in good working order that their wages largely or quite counter-balanced the savings in operators. Experience with modern equipments

demonstrates that the maintenance force need be hardly more numerous or more skilful than that required for manual equipments of equal size; while the faults requiring maintenance are of such a nature as to warrant the expectation of still further reductions in staff.

The expenditure in wages constitutes the main item of maintenance expenditure; those for materials and replacing parts are practically negligible.

In offices of relatively small size the amount and cost of labour is largely affected by the need or preference for continuous attendance.

A special study was made at office "G" to determine the effect of reducing the hours of attendance. For a period of 11 days, during which 83,000 connections were recorded, all maintenance of the equipment was withheld, with the single exception of removing a fuse from one switch to put it out of operation. The equipment gave satisfactory service throughout the period. For an equal number of connections just prior to the test the percentage of errors (failures to obtain proper connections) was 0.27 per cent.; at the end of the test the percentage of error had risen to 0.57 per cent. In a later test the maintenance and repair of the equipment was suspended for a period of six weeks; attention was confined to recording the errors and removing the fuses from switches marked as frequently producing errors. During this test the percentage of error did not change substantially, but at the end of the period 12 per cent. of the selectors had been temporarily withdrawn from operation for cleaning or repair. The switching service was satisfactory throughout.

These instances indicate that with apparatus of good construction the quantity of labour can be largely reduced by withdrawing attendance during slack hours, nights, and Sundays.

A minimum attendance probably can be reached by employing one man in a single shift of eight hours during the busy portion of the day. For a 1,000-line exchange this would result in 2.5 man-hours per line per year. Studies made in exchanges "G" to "K" indicate that the time of the attendant would be occupied to only a very small extent in inspecting, testing, and repairing the switching machines. For example, in exchange "G" the average time for discovering and correcting a fault or defect was three minutes; and all such work occupied about one hour per day. A study in exchange "J" shows for a month a total of 6.5 hours in discovering and eliminating faults (averaging 12 minutes for each case), 19.5 hours for routine testing, 45 hours for inspection, and 57 hours for cleaning. The extent to which the spare time of the attendant can be utilised for maintaining the power plant, distributing frames, and manual equipments has not been determined.

The difficulty of obtaining men of sufficient skill and training for maintaining an automatic equipment often has been unduly emphasised. No doubt upon first examination a machine-switching system produces the impression of being complex beyond the grasp of many minds; these complexities, however, are readily resolved by a moderate amount of steady and continuous thinking into quite simple mechanical operations which make an unusual demand on the mind only in respect of the number of associated parts and of operations in sequence.

A machine-switching equipment of either of the available types, of modern construction, and of moderate or large size, can be kept in good operating condition with an expenditure of labour not exceeding 5 or 6 man-hours per line per year, and the expectation may be entertained of reducing the labour in fairly large equipments to one-half that amount or less. Such a high quality of mechanical performance has already been reached that the number of man-hours per line per year is determined by the necessity or desire to have men present in the exchange during a part or all of the day, rather than upon the amount of skilled repair or interference in the equipment.

Depreciation of Machine-switching Apparatus.

The actual depreciation—wear, breakage, and deterioration—in a machine-switching equipment is not heavy, and eventually may be found to be less even for the present types than the rate of depreciation commonly assumed for manual equipments. In the case of machine-switching equipments of the type described, rather more than one-half of the value of the plant (as an average of 60 offices) consists of the apparatus familiar in manual equipments—distributing frames, meters, cabling, relays, and power plant; the remainder consists of automatic switching machinery, and power apparatus for it. The customary rate of depreciation would naturally be applied for the sorts of apparatus well known in manual practice. As to the switching machinery, sufficient experience has accrued to warrant the expectation of a rate of actual deterioration in no case greater, but possibly less. Office "G" of the motor-driven type described, after operating six years, was examined in detail with great care. The motors and clutches showed wear so slight as to warrant the expectation of useful life several times the period of service. The bronze terminals and brushes showed little more than glazed markings upon their surfaces, and were deemed suitable for 50 years' life. The sequence switches showed very slight wear. A few pivots exhibited wear, while about 100 of the small interrupter levers had required replacement. On the whole it would appear that the replacement or improvement of the interrupter levers would put the equipment in condition for certainly six, and perhaps 12, years of further service.

The expenditure for replacing parts in four machine-switching equipments during nine months fell within £5.

Although exact comparative data are not available, it would appear that the repairs in machine-switching systems will be fewer and less expensive than the repairs to cords alone in manual equipments. In view of these facts it is the opinion of the author that an actual rate of deterioration for a machine-switching equipment may be assumed conservatively to be equal to that of a manual central-battery equipment.

An element which is important in estimating depreciation as a factor in studies of annual charge is the probability of displacement by improved apparatus. This is always a difficult factor to evaluate, but in the present circumstances a partisan of machine switching might find warrant for assigning to it a larger value for manual than for automatic switches.

Discussion.

In the discussion in London, Mr. Frank Gill said this was an engineering, and not merely a mechanician's, paper. The author appeared to regard lost and delayed calls as the same, but one could tolerate a much greater error if the call was merely delayed than if it were lost. The paper showed the great variation in the number of switches required according to the system of computation adopted; it was important not to put in too many switches. The number of calls delayed was not nearly so important as the number of seconds delay. The author really gave no help in the matter of first cost, and they could not move until they knew what it was. Had any of the cases referred to been put in on the basis of economic selection, or merely as being the proper thing to do? If the manual cost were taken at 100, then the automatic first cost would, he suggested, be something like 140 to 145.

Mr. Laidlaw drew attention to the increasing annual cost of operators' wages in manual installations. There were over 3,000 exchanges in the United Kingdom; about half the subscribers were on exchanges of less than 1,000 lines, and for such, the step-by-step mechanism was probably better than the motor-driven, and the 100-line switch was probably the most suitable for the small exchange. It had been shown that the manual operator's efficiency rapidly fell off if more than one station was taken. The figures for manual operation given by the author showed a high order of service, and did not favour automatic working.

Col. C. B. Clay, after mentioning that it had been desired that someone should speak on behalf of the relay system, said he could not help wondering whether a system requiring so much mechanical and electrical mechanism could in the end compete with a pure relay system. The latter would work with greater variation in voltage, and with greater variation in speed of the calling device. It appeared that the maintenance cost of the relay system was very small, and he hoped to get valuable data on this point from the 1,000-line exchange at Stockholm. Experience showed no case of dirty contacts so far. Relay apparatus would, he thought, be more easily dealt with by telephone men than mechanical plant, and as a manufacturing problem, "nothing but relays" was ideal.

Mr. A. J. Stubbs said the Post Office had five systems of automatic switches under trial, with a view to securing the combination of trunk working with local service. He thought standardisation was a matter for the future, but the Post Office had introduced a similar dial system in all cases.

Mr. Dane Sinclair congratulated the author on the cleverness with which he had got over many difficulties. As far back as 1883 he (the speaker) had patented an automatic telephone, but it gave place to the manual system, though he never lost faith in it. He regretted that the author had chosen new names for many parts.

Mr. Aitken said he presumed the author was as much in favour of the "full" as the "semi" automatic system referred to in his paper. The automatic system was now in use in every progressive country in the world; there were really only two systems, the Strowger and Mr. McBerty's, both of which were excellent, but not final. There was also the relay system, which scored in some respects; it was instantaneous in action, whereas machine switching required a time interval between contacts; it also involved only fractional movement, and practically avoided wear and tear. As regarded maintenance, it was interesting to see how the author confirmed the figures he (the speaker) had given in a paper in 1911 on the Strowger system; these figures were much doubted at the time, but apparently maintenance was a very small matter indeed.

Mr. Anson discussed the author's traffic curves. Manual working was a different problem to automatic working; in the latter it was a question of minutes, while in the former it was "calls," on which the tariff system was built up. The Post Office obtained their own empirical curve, and only connected 75 per cent. of the estimated number of subscribers. To design an automatic installation on manual statistics, without due allowance, would lead to errors.

Mr. Petithory said the first automatic telephone patent was taken out in 1879, and the basic patent was the Strowger,

which was the first system to prove successful. He considered that a storing device was very useful for semi-automatic working.

Mr. Ward thought the tendency was in favour of replacing mechanical devices by electrical ones, and that the relay system would supersede other methods. The power required by a relay was so small that destructive arcing was absent; machine switching also required mechanical as well as electrical knowledge, while relay working was a natural development of present methods.

Mr. Grinstead agreed with the author's deductions from data, &c., and as to their value in the design of automatic exchanges.

Mr. John Lee asked where the exchange was in which the operators worked at 600 calls an hour, as machine work could not much better this.

Mr. H. H. Harrison said he could show the author a switch which would make hundreds of contacts per second, and yet stop with certainty when it came to an idle trunk or line.

The Author decided, owing to the late hour, to communicate his reply to the *Journal*.

THE TELEGRAPHIC COMMUNICATIONS OF THE EMPIRE.

In the Final Report of the Royal Commission on the Natural Resources, Trade, and Legislation of the Dominions, an important section is devoted to the subject of telegraphic communication between the various portions of the British Empire. As stated in the Second Interim Report, the Commission is convinced that the feeling of devotion to the Empire and of loyalty to the Mother Country will be strengthened in proportion as increased facilities are offered for keeping in close personal touch with friends and relatives overseas. While this is especially true of the Australasian Dominions, which are the most distant from the capital of the Empire, it applies also to Canada, Newfoundland, and South Africa.

At present cable communication, apart from its commercial use, is practically a luxury; the full charges for messages are as follows: Australia, 3s. per word; New Zealand, 2s. 8d.; South Africa, 2s. 6d.; Canada 1s. 0½d. to 1s. 6½d.; Newfoundland, 1s. 0½d. per word, with reductions for deferred, week-end, Government, and Press messages. The full charge for wireless service to Canada and Newfoundland is 8d. per word. The popularisation of the cable service can only come with a simplification of the charges and their radical reduction, and the Commission would like to see some bold reform in the direction of lower rates analogous to the adoption of penny postage. A charge of 6d. per word for messages in plain language to and from the remotest parts of the Empire is mentioned as a possibility, which would attract an immense amount of traffic, but any drastic reduction of rates by private cable companies is regarded as out of the question, though credit is given them for their efforts to foster communication within the Empire during the war, resulting in utilisation of the cables to a far greater proportion of their full capacity than ever before. The necessity for the cable companies periodically to renew their landing licences does not afford effective control or lead to the cheapening of the services, the power possessed by Government in this respect being used mainly to prevent unreasonable rates; in point of fact, landing licences which expired in 1911 and 1915 have not yet been renewed, owing to the refusal of the companies to accept a clause providing for the control of rates. However, the Commission regards it as urgently necessary to require all companies to supply periodical returns of their traffic, and of the distribution of the traffic throughout the 24 hours, on which points no recent information is available, though such particulars are essential to enable the Governments of the Empire to deal with the subject with adequate knowledge.

The most direct method of securing reductions of rates is that of providing State-controlled telegraphic communication between the United Kingdom and Australasia by way of Canada. In the three Dominions concerned there is a strong feeling in favour of the project, and there is already a through service under State control from Montreal to Vancouver Island, over a leased telegraph wire, and thence to Australia and New Zealand by the Pacific Cable. To complete British control, a cable across the Atlantic and a land line from Nova Scotia to Montreal are needed. There are 17 Atlantic cables, stated in 1911 to have an average capacity of five to five and a half million words per annum, and an actual traffic of two and a half millions; owing to technical improvements, the average capacity of each cable, working duplex, is now estimated at 10 million words per annum at least, while the utilisation factor is believed to be not more than 40 per cent. of the maximum capacity. With an unused capacity on existing lines of six million words per cable per annum, or a total of 102 millions, there is no need to increase the number of cables. The Commission holds, therefore, that one of the existing Atlantic cables should be leased, or otherwise secured for Imperial purposes, and that a land line to Montreal from the landing point of the cable in Canada should be erected or brought under State control, the whole being placed under the administration of the Pacific Cable Board.

In 1915-16 the Pacific Cable carried a load of paying traffic amounting to eight million words; the receipts were nearly £300,000, and the cable paid its way, the average rate for paying traffic of all classes being 8½d. per word. Allowing an average of 9d. a word from Montreal to Australia and New Zealand, and calculating on the basis of the pre-war traffic distribution, with the reduced rates for deferred messages, &c., the Commission estimates that the full ordinary charge should be 1s. 4d. a word, to which must be added 10s. for transmission between the United Kingdom and Montreal, making an ordinary full rate of 2s. 2d. per word between this country and Australasia; the deferred rate would be 1s. 1d. and the week-end rate 6½d. per word.

This calculation is based on the assumption that the traffic will be divided as follows:—Ordinary 38 per cent., deferred 19 per cent., Government 6 per cent., Press 13 per cent., deferred Press 12 per cent., week-end 12 per cent. It has also been assumed that the ordinary Press rates will be one-sixth instead of 5/24 of the full rate.

These rates could be further reduced if the charge of 10d. paid to the Atlantic cable companies, which appears unduly high, could be brought lower. Assuming that an income of £100,000 per annum at the outside would cover the costs to Montreal, five million words at a full rate of 8d. per word, or 4.8d. per word on the average, would suffice. The full rate between the United Kingdom and Australia and New Zealand could then be reduced to 2s., the deferred rate to 1s., and the week-end rate to 6d. It has been taken for granted that the present terminal charge of 5d. per word on full-rate messages made by the Commonwealth Government would be largely reduced, and that the proposed reduction of rates would attract sufficient traffic to maintain a full load on the Pacific cable. The reductions are put forward as the minimum required in the interests of the Empire.

The acquisition of an Atlantic cable would also enable Canadian business to be handled, as the Pacific cable traffic would not adequately load the Atlantic cable and land line. A difficulty is met with here, as unrouted messages to North America have to be handed to the Western Union Co. as representing the Anglo-American Telegraph Co. But this arrangement ceases in 1920, and traffic could be attracted to the State-controlled cable by the lowering of rates and the opening of offices by the Pacific Cable Board in the larger centres of the United Kingdom and Canada. Lastly, by the State control of an Atlantic cable the distribution of Press news to Canada and the Empire—which the Commission regards as a very urgent necessity—would be facilitated, the lowest possible rates being charged.

The State-controlled cable should land in Newfoundland and be laid thence to Nova Scotia, to increase the speed of working and give the Colony the advantages of the cheaper services; if this is not practicable, a land-line should be erected from the landing-place of the cable in Canada to the terminus of the Newfoundland Government cable at Canso.

As regards South Africa, while the rate of 2s. 6d. per word is high compared with 2s. 8d. to New Zealand, the traffic receipts have been so small that the private companies providing the service have been entitled to receive the full subsidy of £13,500 from the Governments concerned and the British South Africa Co., which is payable until 1919. The Commission advocates the encouragement of social and non-urgent messages by a reduction of rates, and advises the Governments to pay temporarily a larger subsidy.

The Commission believes that the nationalisation of the cable service will soon become one of the most urgent problems for statesmanship. It appears difficult, if not impossible, to attain the desired cheapness of cable communication throughout the Empire without interfering with the rights of private companies, who have done much in the past to facilitate development of the Oversea Dominions and to maintain the United Kingdom as the greatest world market; the Commission pays a tribute to their achievements, and deprecates any action which would deprive them of the reward of their enterprise. On the other hand, the urgency of making cable communication available to all classes is described as manifest and imperative. Some propose to await the probable developments in wireless telegraphy before considering the acquisition of private cable lines or Government guarantees, and the Commission recognises the assistance afforded by wireless communication in causing the reduction of rates and multiplication of services, but it is pointed out that on the grounds of speed, certainty, and secrecy in time of war, the cable will long continue to hold the field as the most reliable means of telegraphic communication overseas. There has been no slackening in the pace of cable construction since the advent of wireless.

The British Trade Corporation.—His Majesty's approval was given on April 14th to the draft of a Charter of Incorporation for the above corporation.

THE AMERICAN ELECTRICAL INDUSTRY IN TIME OF WAR.*

The present critical situation in regard to our international affairs finds the electrical industry ready and willing to do its share. Already many organisations of electrical men and a great many individual companies have pledged their support to the administration, and it is very gratifying to note the large number of prominent electrical men who have been called upon, either in an industrial or an engineering capacity, to help direct the preparedness programme now actively under way. An indication of the times is the action taken by the copper producers in voluntarily agreeing to supply the Government with all of the copper required for the army and navy at a price of about 17 cents per pound, which, at the time of writing, is just one-half of present market prices. Approximately 50,000,000 pounds of copper will be supplied at this price during the next twelve months. Figured conservatively, this represents a saving equal to the annual interest on a bond issue of $200,000,000. Equal patriotism has been shown by many of the largest and most prominent electrical manufacturers, who have offered to turn over for Government use, *without profit*, their entire organisations. The central-station industry has been prepared. Already mobilised, ready to serve the individual, the community and the nation, whether for peace or war, solidly and surely founded, it stands, not the creation of a moment's hasty, frenzied action, but the evolution of wise, far-sighted policy, careful and painstaking development and judicious fostering. Long since have intensive co-operation and unified effort been the key note for the cheap and reliable generation, transmission and utilisation of electrical energy. Increased outputs, overloads, long hours and overtime are the order of the day. The solution is to resort to central-station service in the vicinity of arsenals, fortifications, army posts, navy yards, &c. It is available without costly delays and without the necessity of finding extensive capital which in any case can be better utilised in other ways.

While industrial preparedness is, without doubt, of vital importance, the country is sorely in need of men for active service. The President has recently issued orders for the recruiting of the United States Navy to its present authorised war strength of 87,000 men, which will require immediate enlistment of about 25,000 recruits. The idea is to bring the first line of national defence up to condition of immediate maximum efficiency. In this work also can the electrical industry be of inestimable service to the country. Employers are undoubtedly sorely taxed to keep the number of employés abreast of the demands in their factories; nevertheless it would be a wise and far-sighted policy on their part to encourage enlistment for the younger men, such as apprentices, since aside from patriotic considerations, the training is a very good one, and the men return much better able to take their places in the electrical industry.

Another phase of the preparedness programme is open to electrical dealers, namely, that of maintaining window displays designed to encourage enlistments. The cause is a worthy one, and the dealer who so participates gains prestige in his community, and must necessarily gain satisfaction from the knowledge that he is doing his part.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Fault Localisation.

With reference to my letter, published in to-day's issue of your journal, will you kindly correct a printer's error in the last equation, which should be—

$$\text{Distance of fault from A} = \frac{\text{A F K} \times \text{length of A B}}{\text{A F K} + \text{B F L}},$$

not A F K × length of A B (A F K + B F L) as printed.

H. E. Blake.

Eastbourne Electricity Works,
April 20th, 1917.

[The expression should have appeared A F K × length of AB/(A F K + B F L); unfortunately, the slant line was omitted.—EDS. ELEC. REV.]

Electric Fires.

The articles by "Experiment" and "Hot Air" appearing in your issues of March 2nd and March 16th respectively, touch on a matter open to much controversy.

There is something to be said in favour of the "convector" or "low temperature" form of electric heater, and much for the "radiant heat" type. For distinction, one can classify them respectively as "air warmers" and "fires." They both have their peculiar scope of usefulness. The salesman can, of course, more easily create a favourable impression in the mind of a visitor to his showroom with the aid of a cheerful-looking electric fire; and it is also certain that the quicker that cheerful appearance manifests itself after switching on, the sooner he will effect a sale. There is no necessity to have a highly concentrated and intense or built-up heat to give this desired effect.

So far as high-temperature apparatus is applicable, an ample area of hot glow, combined with a free ventilation of the heating medium, seems to be the ideal arrangement, and the one that gives most general satisfaction. For although the test usually employed in the showroom is the heating effect on the hands of the lady buyer, or the posterior of the male visitor, the ultimate opinion is founded on the general heating effect in the room at home, or office, in addition to the cheerful appearance.

Most people do not spend their day warming themselves by the fire, and there is no need to, if the fire fulfils it prime duty of raising the general air temperature of the room to a comfortable degree; and this is most quickly done by a circulation of the air through the fire. That warm air is of some practical use, is made pretty certain by the fact that very many buildings are heated entirely by steam or hot-water radiators.

Those in doubt should try the effect on the person on entering a room in which a boxed-up and most intensely radiant-heat fire has been working for, say, 20 minutes, as compared with a radiant-heat fire that also promotes air circulation—starting from similar conditions. We think the result will be pretty conclusively in favour of the latter. In passing, might we add that this useful combination of a good radiant heat with warm air circulation obtainable in an electric fire constitutes a big advantage over the gas fire. The air passing through a gas fire *has* to go up the flue pipe, and it is for this reason that gas-fire makers are so keen upon getting the maximum possible percentage of radiant heat.

We, unlike the firm referred to by "Experiment," welcome criticism as the sure road to perfection. We don't care a cent what sort of good fire we make. We are unbiassed. Our chief point is: "Is this fire going to sell?" And if it sells—and *continues* to sell—we know it to be good.

The speakers at the N.E.L.A., in their reference to electric water-heating, had evidently come fresh from a study of the comparative heat units in a pennyworth of coal and a pennyworth of electricity at market prices. Such a comparison, although giving one furiously to think, causes no despondency in the stout-hearted, because it has been amply shown in practice that with units at a halfpenny (*i.e.*, where the market price of British thermal units is at the rate of 6,800 a penny), and with suitable apparatus, electric water-heating is not only feasible, but will, in due course, become highly popular, because it is a service at a reasonable cost, and embodies enormous advantages over other forms of heating.

Belling & Co.

London, N., *April 24th*, 1917.

Municipal Electrical Publicity.

The suggestions of Mr. E. P. Hollis for organising a publicity department are very interesting, and consist essentially of a combined publicity and selling department controlled by one head.

The publicity engineer, under this scheme, would require to devote most of his time and energies to duties which properly belong to the selling engineer.

The work of collecting, analysing, indexing, and collating technical data, and reproducing them in an interesting and readable form, would, in practice, require the whole time and attention of a properly organised publicity department.

To obtain successful results, two departments would require to be organised—viz., a publicity department and a selling department, each under the direction of a qualified engineer. The publicity engineer with literary ability and experience in systems of dealing with technical data as mentioned above, and the selling engineer with commercial experience in addition to his technical training.

The publicity department would not only publish interesting literature for public consumption, but would also keep the selling department, and other sections of the electricity supply undertaking, constantly supplied with up-to-date information, including prices and useful technical data systematically arranged for easy reference.

The most successful selling departments are built on the foundation of well-organised and systematic publicity departments, and successfully to carry out such a campaign as outlined by Mr. Hollis, a selling department, with an efficient publicity department behind it, would be necessary.

D. Ross Kennedy.

April 21st, 1917.

The I.E.E. Nominations.

I am instructed to inform you that at a meeting of this Association the following resolution was passed:—

"That the members of the Association of Municipal Electrical Engineers of Lancashire and Cheshire congratulate Mr. Wordingham on being nominated as President of the Institution of Electrical Engineers, and desire to place on record their high appreciation of the services rendered by him to the profession over a long period of years.

"The Association regrets to note that opposition to the nomination of Mr. Wordingham has arisen in certain directions, apparently because he has at times offered candid criticism on various matters which have been the subject of debate at engineering meetings. The Association feels that, instead of criticism being the ground

* American *Electrical Review and Western Electrician*, March 31st.

for objection to Mr. Wordingham's nomination for this office, it should rather be considered a qualification, as honest criticism must at all times act beneficially in regard to any subject of a debateable nature.

"The Association enters its strong protest against the unfair attacks which have been made against Mr. Wordingham's nomination, as, by reason of his official position, he is obviously unable to reply thereto."

The following members were present and signed the resolution :—S. L. Pearce, J. A. Robertson, R. Blackmore, H. Dickinson, S. J. Watson, P. P. Wheelwright, H. Wilkinson, C. L. Stewart, A. T. Smith, W. J. H. Wood, A. W. Clegg, C. J. Wood, W. Chamberlain, J. E. Starkie, D. H. Davies.

W. J. H. Wood,
Hon. Secretary, Association of Municipal Electrical Engineers, Lancashire and Cheshire.

Manchester, *April 24th*, 1917.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.

Reel for Use in Pulling Wires into Conduit.

When wires are being pulled into conduit, unless they can be cut off before they are pulled in, they are inclined to tangle badly. To overcome this trouble, Mr. F. Boone made a reel that solves the problem very well.

Two wheels are first made from about 1-in. board, and turned to about 10 in. in diameter. A 1·125-in. hole is bored through the centre of each, and slats are nailed on the edges of the wheels about 2 in. apart, so as to form a sort of squirrel-cage cylinder. These slats should project over the edge of one wheel 1 in., and be flush with the edge of the other wheel. On the face of the latter, six or eight radial slats or spokes are nailed to keep the wire from slipping off. Another wheel is made like the two already mentioned, but not necessarily as thick, and on one face of this are nailed radial slats, to correspond with those on the flush

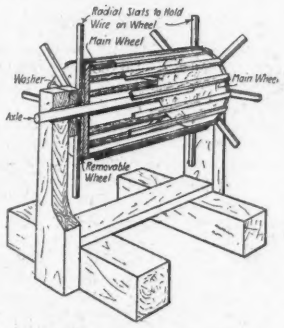


Fig. 1.—A Handy Reel.

end of the squirrel cage. A frame is made with heavy base blocks to weight the whole reel properly and keep it from tipping over when the wires are pulled. The accompanying sketch shows the general arrangement, one end being partly broken away to show the detail. A piece of conduit will serve as axle, and a block or thick washer should be nailed inside the frame.

In using the reel, it is bodily taken from the frame, and the removable wheel slipped off. The bundle of wire to be used is split, and half of it is turned round ; then the whole bundle is slipped over the reel at the end where there are no spokes. If more than two wires are to be pulled in, other bundles are put on the reel as may be necessary. The removable wheel is again put on, its spokes closing the free end and the projecting longitudinal slats fitting in between these spokes to keep the wire from getting between the two adjoining wheels. The reel is then put back in the frame, and the wires are ready to be pulled. By turning half of each wire bundle round before putting it on the reel, it is possible to pull wire in the same direction from each half of the bundle without tangling.—*Electrical Review and Western Electrician.*

Electric Heaters Used in Making Bank Notes.

In the Bureau of Engraving and Printing, Washington, D.C., there are 600 electrically heated industrial stoves in use for the heating of engraved plates from which bank notes are printed. These units (made by the Cutler-Hammer Manufacturing Co., Milwaukee, Wis.) are spring-mounted in a cradle, so that there is a pressure upward against the under side of the plate. The construction is diagrammatically shown in fig. 2. The heater units are united to the top plate of the stove by electric welding, and the top plate and heating units therefore become virtually one piece. There is perfect and permanent contact, and the heat is generated right where it is needed. The upper plate is of steel.

Electric stoves of this construction can be made in sizes and shapes to suit various applications, such as for velouring in hat factories, for sweating on machines used in mounting electrotype

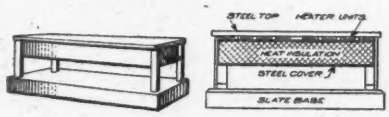


Fig. 2.—Electric Heaters used in Engraving.

metal blocks to the copper shell ; for embossing work ; for laboratories ; and for many industrial purposes. The heat is uniform, can be easily controlled, and is not affected by draughts of air. The 600 stoves in the Bureau of Engraving referred to above, if heated by gas or other agent, would vitiate the air and foul the walls and ceiling. As a central-station load the electric industrial stove is very favourable, because of its many possible applications.—*Electrical Review and Western Electrician.*

A Petrol Engine with Electrically-Operated Valves.

Not content with the important part that electricity plays in the running of the petrol engines of motor-cars—such as ignition, starting, &c.—Mr. Jos. C. Youngblood, of the Youngblood Automobile Co., of Atwood, Kan., U.S.A., has gone a stage further by designing and constructing an engine, the valves of which are opened and closed electrically instead of mechanically.

Aiming at a form of construction that will, it is claimed, at the same time reduce the cost of manufacture, facilitate the operation of valve setting, and result in an extremely quiet-running engine, the valve mechanism of the new engine is

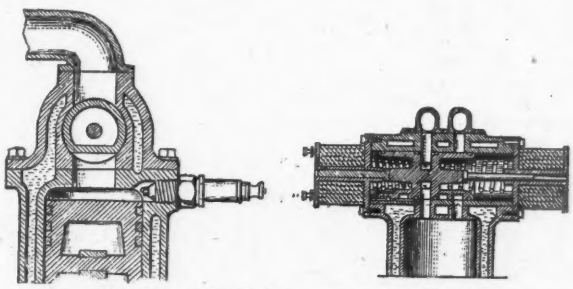


Fig. 3.—Sectional Elevations of the Youngblood Valve-gear.

different in every detail from the conventional type. Across the top of the cylinder, or cylinders, is a cylindrical valve chamber, into which open ports, two of which communicate with the combustion chamber, and two others with the inlet branch and the exhaust manifold respectively. Sliding in the chamber is a piston valve, the centre of which is cut away, so that by a suitable sliding of the valve direct communication can be established between one of the cylinder ports and the inlet branch and between the other cylinder port and the exhaust manifold. With the valve in a central position both ports are closed ; the cylinder ports, however, register with recesses cut in the valve to serve as pockets for any carbon that may be formed.

The piston movement of the piston valves is operated by means of solenoids. From the outer ends of the valve extend axial arms of soft iron, which enter the hollow cores of electromagnets mounted on the end caps of the valve chamber. Between the ends of the valve and the caps are helical springs, which tend to keep the valve in a central position with both ports closed. The windings of the solenoids are energised by current from an accumulator, the current being distributed by a gear-driven timer operating on the same principle as a low-tension ignition distributor. The contacts are, of course, so arranged that the valve movements take place at the correct moment of the piston stroke, and in proper sequence.

New Method of Testing the Acid Resistance of Enamels, Paints, and Varnishes.

Messrs. Jenson & Nicholson, Ltd., of Goswell Works, Stratford, E., point out that the usual methods for testing the acid-proof qualities of enamels, paints, and varnishes which are in practical use, such as coating pieces of iron, zinc, copper, or similar suitable metals, immersing them in acid solutions, and watching the development of corrosion, are of a very primitive character, and possess the disadvantage of not affording any scientific basis of comparison which can be tabulated. A very considerable length of time is required before results of a conclusive character can be obtained. They have therefore worked out a new test with a view to affording a moderately rapid and accurate estimation of the

acid-proof quality of an enamel on such lines as will enable anyone to compare the qualities of acid-resisting coatings in definite terms.

The principle of the test is that of the simple voltaic cell, where an electric current is produced as a result of chemical action. Plates or rods of dissimilar metals—say, copper and zinc—are coated with the enamel or material to be tested and immersed in dilute acid, when, if they are unable to withstand the corrosive action of the acid, a breakdown occurs, galvanic action sets in, and is recorded by suitable instruments, and its intensity forms the basis of comparison of the acid-resisting properties of the coatings.

According to their method, a number of copper rods, each 6 mm. in diameter and about 16 cm. long, are washed clean and dried, and are dipped into the liquid enamel or paint; when dry, the ends are to a distance of 2-3 cm. coated with paraffin wax.

A zinc rod, amalgamated with mercury, is immersed in a vessel containing a solution of 25 per cent. H_2SO_4, prepared with distilled water; the copper rods are spaced round the zinc at a radius of 5 cm. The zinc is connected to one terminal of a millivoltmeter, while each of the copper rods is successively connected up and the potential difference noted. No difference of potential should be indicated at the commencement; should any occur, the rod should be rejected and a fresh one put in its place. The rods should be tested every hour at first, to study the effect, but later at intervals of 6, 12, or 24 hours. A good acid resister should give no potential difference during 24 hours. A reading of 100 millivolts might be adopted as the maximum limit.

THE TRAINING OF DISABLED SAILORS AND SOLDIERS FOR ELECTRICAL SUB-STATION WORK.

Since June, 1916, an important experiment has been in progress, which was first conceived in February, 1916, by the Institution of Electrical Engineers, who approached, and obtained the sympathetic help of, the Education Committee of the London County Council. It was held that a preliminary period of technical training under capable instructors in an institution having up-to-date electrical laboratory equipment might enable men of various grades of education to qualify as sub-station attendants in a much shorter period than otherwise would have been needed, and might give them an enhanced value during the period of station training. The experiment was projected to test the the possibility of such preliminary training.

The Northampton Polytechnic Institute was selected as a suitable training centre in London, and the experiment was entrusted to the Electrical Engineering Department of that Institute. The training, which is intensive, lasts only three weeks, a new course being held each month, and the number of students in each course is limited to 20. The seventh course of the series ended in March, 1917, and the eighth is now in progress. Statistics of these courses are as follows:—

Number of Applications for Admission.

Course 1. June-July, 1916.	Course 2. July-Aug., 1916.	Course 3. 16/10—10/11/16.	Course 4. 20/11—15/12/16.	Course 5. 15/1—2/2/17.	Course 6. 12/2—2/3/17.	Course 7. 12/3—30/3/17.
22	21	22	23	30	22	24
Number Actually Commencing the Course.						
13	20	18	23	19	18	19
Number Approved for Employment.						
13	14	16	20	18	13	18
Number Actually Placed.						
13	12	15	20	18	13	17
Number of Applications from Employers.						
16	42	Over 50	Over 40	Over 45	Over 35	Over 35

Totals for Seven Courses.

Number of applications for admission ...	164
Number actually commencing the course ...	130
Number approved for employment	114
Number actually placed	108*
Number of applications from employers, over	205

* A few of those approved for employment obtained work privately; one or two had to return to hospital.

The disablements which have been found not to disqualify for all posts of the kind at which the training aims, are total disablement of one arm or one leg, or a partial disablement of one limb. Disabled men suffering from shell shock, however, cannot be accepted.

Up to the present time the whole of the men who have taken sufficient advantage of the training to secure the recommendation of the Joint Committee under which the training is being managed have been placed out, and there are still many vacancies to fill, but increasing difficulty is being found in placing men with serious arm disablements. It is suggested that, in certain cases, such men might still be utilised for this work by simple modifications of parts of the switchgear, and the patriotism of station engineers throughout the country is appealed to to consider carefully the possibility of employing men who have lost partially, or wholly, the use of one arm.

The system of instruction was described in our issue of August 4th, 1916. Particulars of the course of training, and the men available, may be had from the Principal of the Northampton Polytechnic Institute, Clerkenwell, London, E.C., 1.

LEGAL.

Pickman *v.* Western Electric Co., Ltd.

In the King's Bench Division, on April 20th, an action was heard before Mr. Justice Laurence and a special jury in which Mr. John Pickman, Elsden, The Chase Cottage, Southminster, sued the defendants to recover damages for personal injuries sustained, as he alleged, through the negligence of the defendants in not properly protecting an electric circular-saw used for cutting up hard woods at their saw mills at North Woolwich, at which the plaintiff was working. The defendants denied negligence.

Plaintiff said that on March 31st, 1916, while he was putting wood into the saw, a piece of wood, getting caught in the teeth, was flung forward and struck him in the right eye, the result being that he had practically lost the sight of that eye. The plaintiff said that the machine was dangerous, being not adequately protected, and he claimed damages.

The Defendants denied that there was any negligence on their part.

The Plaintiff claimed, in addition to general compensation, £55 as special damages.

The jury awarded the plaintiff £250 and the special damages, judgment being entered for the plaintiff for a total of £300 12s. and costs.

WAR ITEMS.

Municipal War Wages.—The Hackney Electricity Committee has received a further application from the employés of the electricity undertaking and the refuse destructor works asking for an increase of wages or an increased war bonus. In view of the recurring applications, and considering the whole circumstances, the Committee is of opinion that the Chief Industrial Commissioner should be asked to consider the matter in all its bearings, and give a decision which it is hoped will settle the question until the time when normal conditions will prevail. The Committee recommends that the borough electrical engineer be instructed to submit the necessary particulars to Sir George R. Askwith, and ask him to decide what salaries or wages should be paid to employés in the electricity undertaking and refuse destructor works as and from April 1st, 1917.

Exports to China.—The "London Gazette" for April 24th contains further names of persons in China to whom exports may be consigned.

Substitution.—The Director-General of National Service has appointed Mr. R. E. Graves to be Director of Substitution, to take charge of the new Substitution scheme.

National Service Department.—Mr. W. A. Appleton has tendered to Mr. Neville Chamberlain his resignation of the position of Labour Adviser to the National Service Department.

Exemption Applications.—At the Driffield Tribunal, an electrician employed at a picture palace, 33 years of age, and passed for general service, was granted an extension of his certificate from April 2nd to July 1st, his contracts in hand not having been completed. The condition was attached that applicant could not appeal again without the permission of the Tribunal.

Worcester Tribunal has granted renewed conditional exemption to Mr. R. E. H. Heenan, resident director of Messrs. Heenan & Froude, Ltd., refuse destructor makers.

Salop Appeal Court have refused a Military appeal against conditional exemption held by the manager of the Oswestry Electric Light Co., aged 25, and in Class C 1, who has sole control of the undertaking.

Martley Tribunal has, after a Military review, confirmed conditional exemption held by Mr. F. Turner (37, in Class C 1), electrical engineer at the Knightwick Sanatorium.

Before the Essex County Tribunal, on April 19th, the Ilford U.D.C. appealed for 11 men engaged on the tramways. The manager (Mr. L. Harvey) said that it was now impossible to release more men if the tramways were to be safe for the travelling public. A reduced service was being run, and in one case the Ministry of Munitions was complaining of the inadequate service of cars. Conditional exemption was granted to the night foreman, the armature winder and storekeeper, an overhead linesman, and six motormen; the cashier was allowed three months, and a second night foreman was directed to join up at the end of May.

At Torquay, a review was made of the case of W. J. Coleman (35), electric jointer and handyman, engaged at the

Corporation electricity works. Conditional exemption renewed.

Before the East Kent Appeal Court, the Military Representative appealed against exemption until May 19th allowed to P. F. Cotton (30), electrician with Mr. V. Hill, electrical engineer, of Broadstairs. It was urged that there was an urgent need in the Army for men with skilled knowledge of electrical engineering. The appeal was allowed, and exemption cancelled.

At Ipswich, the Corporation Electric Light Committee appealed for two men engaged at the refuse destructor, whom they had been unable to replace. Both appeals were refused, and the Military Representative undertook to find substitutes.

At Rotherham, the cases of seven men on the Corporation tramway staff were reviewed. It was mentioned that 75 out of 130 men had been lost, and that substitutes could not be obtained. During the past six months five men had been trained; two had died, and the others could not stand the weather conditions. One single, Class A, man was ordered to join up, and the others were exempted until competent substitutes satisfactory to the Tribunal were found.

Before the Somerset Appeal Court, the Military asked for the withdrawal of exemption held by the chief assistant engineer (31), and a fitter and driver (41), engaged at the electric light and tramway undertaking at Weston-super-Mare. It was urged that there would be danger to the public if the staff was further reduced. The engineer's exemption was allowed to stand, and the other case was adjourned *sine die* for substitution.

At Bexhill-on-Sea, Mr. C. A. Frost, electrical engineer, appealed for further exemption for two shift engineers, as substitutes were being found. A month was allowed to each.

Maidstone Tribunal has granted six months' exemption to J. P. Macrow (30), armature winder, and E. Weller (30), engineer's turner, engaged in the Corporation tramway department.

On the appeal of the Military, Maidstone Tribunal has withdrawn conditional exemption, with a month's grace, held by E. Styance (25), one of a gang employed in unloading coal to the municipal electricity works. The electrical engineer, Mr. E. E. Hoadley, said that the gang had been depleted from 20 to seven.

At Eccles (Lancs.), the borough electrical engineer appealed for a handy labourer at the works, aged 37, who works on the average 87 hours per week. Mr. Angus stated that the man's work was of a special nature, and he could not find a substitute. A Class A man was necessary for the heavy work he had to do. The appeal was dismissed, and the calling up fixed for the end of May.

At Burgess Hill, the Military Representative had a review of conditional exemption granted to the engineer and manager of the Electric Light Co. (39, in Class B 1), and asserted that electric light was a luxury. Respondent stated that he was not only manager of the works at Burgess Hill, but elsewhere. Mr. L. R. Burrows, chairman of the company, who was a member of the Tribunal, urged that it was an important matter for the town. The company supplied current to places of worship, banks, post offices, and some 200 private houses and shops. If the manager were taken, and they could not get another man, the works would have to be closed, which would be a public nuisance. The exemption was cancelled as from May 1st.

At Redruth, on April 14th, the Cornwall Electric Power Co. appealed for their high-tension wire foreman (22, in Class A), and for a high-tension wireman (21). The company claimed that it was in the national interest that they should retain these men; they had been badged, but the badges had been withdrawn. The Military Representative objected to the men being exempted on the ground that they were in Class A, and that it was not in the national interest that they should remain in civil life. The foreman was given six months, and the other appeal was disallowed.

The Surrey Appeal Court has dismissed an appeal for exemption for J. G. Toonjan (23), shift engineer at the Reigate municipal electricity works.

Before the Durham County Appeal Court, the Sunderland and District Electric Tramways Co. appealed against the refusal of exemption to a tramway engineer and foreman (28), and an electrical wireman and tramdriver (25), both passed for general service. It was stated that the company had released 123 employés for the Army, Navy, and munitions, and it was claimed that both men were in certified occupations. Mr. G. Stratton, the manager, said that he had applied for substitutes without success. Conditional exemption granted in both cases.

At Keighley Tribunal, reference was made to the case of an electrical engineer, aged 20, in Class C 3, who was a member of the Amalgamated Society of Engineers, and had held a trade card for the past two months. The Military Representative contended that the card was no use, as he should have had it since before August 15th, 1915. Mr. Liddermore held that that condition was not essential in the case of a man who, as in this case, was a skilled or semi-skilled engineer before that date. This fact had not been placed before the Tribunal at the hearing a few days previously, when four men had been concerned in the case, two of whom were ordered to join up at once. Mr. Liddermore suggested a reopening of the cases. Mr. Morkill (Military Representative) said a circular had been received by recruiting officers giving instructions that whatever might be a decision of a Tribunal, if within an hour of the expiration of a calling-up notice a man, through his employer, could produce evidence that on August 15th, 1915, he was registered so as to come within the skilled or semi-skilled definition entitling him to a trade card, the papers should be cancelled. It was agreed that the man concerned should be made aware of this position.

BUSINESS NOTES.

Book Notices.—"The Electrical Review's Electrical and Allied Trades Directory" (The Red Book.) London: H. Alabaster, Gatehouse & Kempe. Price 21s.—Notwithstanding all the difficulties that the war has naturally placed in the way of compilers of directories in which an important feature is made of foreign entries and corrections, the Red Book for 1917 has made its appearance looking as business-like as ever, but under a slightly altered title. It has dropped the "Universal" from its name, because certain countries, some of which shall be nameless, have no longer place within its covers—they are, for the present at least, outside the pale of Civilization, and nobody wants to know the addresses of those with whom they do not want to communicate even if they could. Attention has been concentrated in this edition, more particularly upon information which will be useful in encouraging business relations in the United Kingdom and between works and traders in the Mother Country and our Colonies and Dependencies overseas. As far as possible the entries of alien enemies in neutral countries have also been eliminated. It is believed that all the changes made will enhance the British utility of the volume. All that could be done, in exceptional times, to ensure the making of corrections to bring the contents right up to date, has been done, and we believe that the volume will be found of great service to those who are fortunate enough to secure a copy. The sections into which the Red Book are divided by the usual thumb index are:—British Alphabetical, British Classified Trades, Colonial and General Alphabetical, ditto Classified Trades, and a selected Continental Alphabetical Section of about 100 pages. The number of pages is now 1,164, as compared with 1,56[illegible] last year, but the drop of 25 per cent. in pages is amply made up for by an increase of more than 25 per cent. in its British business efficiency by reason of its special adaptation to a period of exceptional difficulty and expense.

Wiring Hints for Interphones. Bulletin No. 4,015. London: Western Electric Co., Ltd.—This is one of those brochures issued in connection with a firm's specialities which are so full of technical information, expressed in terse and lucid language, that they are of the greatest value to the user, not only of the apparatus primarily dealt with, but also of all apparatus of the same general type. It relates to the automatic replacement interphones of the Western Electric Co., Ltd., and is intended for the guidance of the contractor and his wiremen. A brief description of the equipment is given, followed by particulars regarding the cables, batteries, and accessories required, and a full account is provided as to the proper method of preparing the cable for wiring in workmanlike fashion, with ample detailed illustrations which render errors, if not impossible, at any rate inexcusable. Simple rules for connecting are also given, and methods of finding and clearing faults (in the unlikely event of their occurrence) are described. An explanation of the working of the sets, with diagrams of the circuits, completes the booklet, which is a model in style and substance. It should prove most useful to those for whom it has been written.

"*Proceedings* of the American Institute of Electrical Engineers." Vol. XXXVI, No. 4. April, 1917. New York: The Institute.

"Preliminary Mathematics." By Prof. F. E. Austin. London: E. & F. N. Spon. Price 5s.

Trade Announcement.—The Yorkshire Electric Wiring and Motor Co., Ltd., of Sheffield, have removed from Waingate to 4, Lady's Bridge.

Storage Batteries for New Zealand.—H.M. Trade Commissioner in New Zealand (Mr. R. W. Dalton) reports that a firm at Wellington desires to get into touch with United Kingdom manufacturers of storage batteries for power station and country house lighting, with a view to representing them in New Zealand after the war. This agency is wanted in conjunction with an agency already held, in order that the firm may be in a position to offer a complete installation of power plant. Communications should be addressed to the Department of Commercial Intelligence, 73, Basinghall Street, London, E.C., 2. (Reference 150).—*Board of Trade Journal.*

Catalogues and Lists.—In connection with the restriction Order relating to the distribution of catalogues, &c., the production of which was ordered and commenced before March 3rd, the Paper Commission has been authorised by the Board of Trade to extend by general licence until further order the period during which such distribution will be lawful.

The Telegraph Condenser Co., Ltd., Vauxhall Street, Kennington Oval, London, S.E.—The catalogue (40 pages) issued by the company contains full description and numerous illustrations

of different types of artificial lines for duplex working on submarine cables, especially the Dearlove patent type with negligible temperature coefficient; condensers for submarine cables; other condensers, artificial cables for universities, colleges, and science schools, &c. A supplementary list of eight pages shows developments, including artificial cable for telephone experiments, "T.C.C." type telephone condensers, and Mansbridge condensers.

Messrs. Arnold Goodwin & Son, Ltd., Sumner Street, Southwark, London.—Illustrated list showing a number of their runways in service, also giving prices of "Beatall" lifting blocks and travelling carriages.

Messrs. Dick, Kerr & Co., Ltd., Abchurch Yard, Cannon Street, London, E.C.—Folder giving prices of Britannia drawn-wire lamps.

Western Electric Co., Ltd., North Woolwich.—*Bulletin* No. 4,015 (24 pages) contains full particulars, with wiring and other diagrams and illustrations of the company's system of automatic replacement interphones.

Messrs. Scholey & Co., Ltd., 56, Queen Victoria Street, London, S.W.—A series of small leaflets issued in connection with the Taylor stoker. They relate to the saving of labour and upkeep of boilers, the increase in capacity of boilers, and the ability to meet sudden overloads accruing through the use of this stoker, also its advantages in connection with the use of low-grade fuels.

British Thomson-Houston Co., Ltd., 77, Upper Thames Street, London, E.C.—Eight-page reprint from the "Beama Journal" of an illustrated article on "Industrial Fittings for Half-Watt Type Lamps."

The General Electric Co., Ltd., 67, Queen Victoria Street, London, E.C.—Three new publications: No. V 2,088 gives illustrated particulars and prices of "Witton" moulded insulation terminal blocks; No. L 2,093 describes the G.E.C. haulage road-signalling system for use in collieries; and No. O 2,104, deals with the "Kingsway" miners' electric hand lamp.

Dissolutions and Liquidations.—British Electrical Accessories Manufacturing Co., Ltd.—Mr. E. Fisher, of 12, Cherry Street, Birmingham, has been appointed receiver as from April 4th. It is expected that there will be a dividend of about 5s. in the £.

Alphons Custodis Chimney Construction Co., Ltd.—The controller, Mr. D. H. Allen, has applied for his release.

Anglo Engineering Co., Ltd.—By an order dated March 28th, Mr. G. E. Corfield has been appointed an additional liquidator to act with Mr. A. E. Tilley.

Universal Light and Sign Co., Ltd.—A meeting is called for May 25th at 35, Coleman Street, E.C., to hear an account of the winding up from the liquidator, Mr. J. H. Anneveld.

Birmingham Belting Co., Ltd.—A meeting is called for May 24th, to hear an account of the winding up from the liquidator, Mr. E. Taylor.

Auto-Flash Sign Co., 119, High Holborn, and Rickmansworth, lately at 4 and 5, Glebe Road, Kingsland Road, Dalston, as the Patent Distributor and Times Switch Co.—Messrs. W. B. Garstin & W. R. Scott have dissolved partnership.

Climax Stopper and Ebonite Co., Ltd.—A meeting of creditors is to be held at Normandy Works, Normandy Street, Custom House, E., on May 2nd. Mr. C. A. Henderson, liquidator.

Adnil Electric Co., Ltd., London, E.C.—Second dividend of 3s. 6d. in the £, payable April 30th, at 6, Clement's Lane, E.C., 4.

Wholesale Traders' Association.—The fourteenth annual meeting of the Wholesale Traders' Association for the Protection of the Hardware, Furnishing and Metal Industries, Ltd., was held at the offices at Birmingham on April 19th. Major J. H. Cartland, J.P., who presided, stated that the operations of the Association had again been fully maintained, and that the members had made extensive use of its various departments, which had afforded them exceptional facilities and assistance in many directions under the present abnormal conditions; 138 new members had joined the Association during the year, bringing the total membership to 3,195. Notwithstanding the war, and the fact that a large number of firms were doing Government work, and, therefore, were not seeking to open new accounts, the number of status inquiries sent in during the year had reached the enormous total of 72,772, involving a credit of over £6,000,000, thereby showing that there was still a good general trade being done by the various manufacturers and merchants throughout the country, and that a large number of orders had been received from foreign and colonial markets which they were unable to execute at the present time. In the debt recovery department 22,690 cases were sent in for collection, aggregating in value £224,137, and out of this sum only 8½ per cent. proved irrecoverable or bad. In the insolvency department there had been a considerable decrease in arrangements, bankruptcies, and companies' liquidations, but a large number of cases had been reported during the year where meetings had been attended and combined action taken in the interest of members. The secretary reported concerning the Association's activities relating to the Registration of Business Names Act. No fewer than five of the Association's amendments were included, wholly or partly, in the Act. Up to date about 75,000 firms had already registered. The working of the Act had shown the importance of some amendment being made in the Companies' Acts, and the secretary was instructed to take whatever steps he thought necessary, in conjunction with others, to bring about this result.

LIGHTING AND POWER NOTES.

Australia.—The report on the results of working of the Melbourne City Council's electricity undertaking for the year ended December, 1916, shows revenue amounting £197,100, an increase of £14,505; an expenditure of £94,849, leaving a gross profit of £102,250. After deducting £54,339 for capital charges and depreciation, £6,540 sinking fund, £3,654 payment to employés on Active Service, and £1,454 special expenses, there remains a net profit of £36,263, £36,000 of which the Committee proposes to allocate to the loan fund. The sinking fund now stands at £141,828.

In the discussion which followed the presentation of the report, a resolution was moved that the accounts be referred to the Finance Committee, it being claimed that the Electric Supply Committee should not arrogate to itself the right of allocating amounts to any funds. Alderman Cabena, the chairman of the Electricity Committee, said he objected to one Committee controlling another; if the Finance Committee was to control the accounts of the Committee of which he was chairman, he would resign. The resolution to refer the accounts was carried by 13 votes to 6, and Alderman Cabena intimated his resignation from the Committee.—*Melbourne Age.*

In connection with the electric lighting department of the Cottesloe (W.A.) Municipal Council, during 1916 the number of consumers increased to 1,185 and the consumption to 242,720 units. The Council is now arranging an agreement with the Fremantle Tramway Board for a 21 years' service, and, under the new system, it is proposed to spend £3,000 to make the necessary changes in existing fixtures.—*Commonwealth Engineer.*

A deputation, consisting of the representatives of the Electrical Employés' Association and the Electrical Trades Union, waited on the Lord Mayor of Sydney, N.S.W., recently, to urge the Council to reconsider its decision not to connect new consumers, pointing out that it would result in a number of men being thrown out of employment, and suggesting that the Council should apply to the Railway Commissioners to use the plant at White Bay to generate electricity to enable the electric lighting to be pushed on with. The Lord Mayor said the Council had been in communication with the Railway Commissioners since last April, and he would personally renew the request. If the Westinghouse Co. was prepared to do the work of constructing the engines required at before-the-war contract rates, there was no doubt that the Council would have no hesitation in signing a contract and procuring the machinery as rapidly as possible.

Birmingham.—A special meeting of the Electric Supply Committee has considered the report of Mr. C. P. Sparks, president of the I.E.E., which approves the Nechells site, and it was agreed to proceed with the erection of the permanent station as soon as practicable.

Blackpool.—Year's Working.—The Corporation electricity department records a loss for the past year—the first for a very long period. The income was £45,791, compared with £44,347 in the previous year, but working costs increased from £25,277 to £28,768, resulting in a loss of £887. Daylight saving and the increased cost of coal were factors. There were 13,904 tons of coal used, at a cost of £12,289. Three years ago nearly the same number of tons cost only £8,775. The total capital outlay to date is £252,191, and there is a loans sinking fund of £133,262, and a reserve fund of £5,223. Only 100 new consumers were added to the mains during the past year. The Committee is to consider a further revision of the charges for current.

Canada.—In an address before the Ontario Municipal Electric Association, on February 15th, Sir Adam Beck reviewed the work of the Ontario Hydro-Electric Power Commission, and spoke on the future of the provincial system. The Commission at present supplies 191 municipalities, and expects to supply over 200 in the course of the next two or three months. Over 200,000 H.P. is now developed by the Commission, with a total investment on the part of the Commission and municipalities of more than $40,000,000. Within five years, Sir Adam expects this amount to increase to $100,000,000. In regard to the future, Sir Adam said his opinion was that the hydro-electric power system must absorb the whole of the electric systems in the province of Ontario.

Formal protest has been made to the Canadian Government by the United States against the proposed Chippawa-Queenstown power canal, by which the Ontario Hydro-Electric Commission will divert additional water from the Canadian channel of the Niagara river for power development. The United States claims that the project would violate the treaty under which the diversion limit above the cataracts is fixed at 20,000 cb. ft. per second on the American side and 35,000 cb. ft. per second on the Canadian side. The Ontario Provincial Legislature has been advised by Attorney-General Lucas that there is no necessity for seeking the consent of the International Joint Waterways Commission to carry out the Chippawa-Queenstown power development project, and, acting under this advice, the Provincial Legislature will proceed with the plans without the permission of the International Commission. The Ontario Hydro-Electric Commission has charge of the construction, &c.—*Electrical World.*

Clayton.—The Bradford Corporation Electricity Committee, last week, considered the matter of electricity supply to Clayton, arising out of the recent controversy in that township as to whether this should be obtained from Bradford or from the

Yorkshire Electric Power Co., the latter of whom has a Bill before Parliament. It is believed that there was a view that it would not pay Bradford to supply Clayton. A Sub-Committee was appointed to make full inquiry, and report to the next meeting of the full Committee.

Haworth (Yorkshire).—An animated discussion ensued at last week's District Council meeting as to whether or not an Electricity Committee should be appointed. In open Council, a motion for the re-appointment of an Electricity Committee was defeated by a majority of one, but subsequently a Committee was appointed.

Hoole.—Workhouse Lighting.—The U.D.C. has assented to Chester T.C. supplying current to the workhouse, which is in the area of the Council.

Hull.—The Electricity Committee has received a communication from the Municipal Employés' Association, asking the Council to receive a deputation in regard to an advance of wages. It was stated that a Special Committee had been appointed to consider the wages question. The acting engineer (Mr. McGoris) was authorised to employ a further batch of women, with whose work he expressed much satisfaction.

In regard to the scheme for amalgamating the tramway and lighting generating stations, the chairman reported that an agreement had been arranged with the Tramways Department in regard to formulating a scheme.

India.—Last year's Administration Report of the Madras P. W. D. states there has been a steady increase in the use of electricity in Madras City. As many as 48 industrial concerns in Madras are now being worked with electric power, these including saw mills, oil mills, flour mills, printing presses and cement works, and if the supply company could only meet the demand, the list would include many more concerns. Works are in progress for conveying current to the suburbs of the Kilpauk Adyar and Royapuram, and the only delay in carrying out these extensions is due to non-receipt of materials from home on account of the war. Altogether, there are in Madras signs of general development, and a readiness to accept new ideas.

At the July meeting of the Bombay Legislative Council, the following resolution is to be moved:—"That this Council recommends that his Excellency the Governor-in-Council will be pleased to place on special duty, at the earliest convenient date, a capable officer of the Public Works Department to report upon the development of water power in this Presidency, both for direct use and for the establishment of hydro-electric plants, the special duty officer being instructed to give approximate costs of the proposed water power schemes, the details being left to be worked out by promoters proposing to utilise the power for industrial purposes."—*Indian Engineering.*

London.—Hammersmith.—The Electricity Committee has had under consideration proposals by the electrical engineer for increasing the ouput of the existing generating plant, by adding induced draught plant, a new boiler feed pump, mechanical stokers, &c. It is expected that another 1,000-kw. capacity can be obtained, and a detailed report is to be submitted.

Marylebone.—The Electricity Committee has received a communication from Sir Arthur Duckham, chairman of the Advisory Committee (Ministry of Munitions), asking the general manager to advise him on matters connected with a proposed scheme and experiments for the economical use of coal.

Annual Estimates.—The estimated revenue of the electricity undertaking for the year ending March, 1918, is as follows:—From sale of electricity to consumers, £187,500; from public lighting, £14,850; meter rents, £8,100; sale of fittings, &c., £11,280; rent of properties, plant on hire, and sundry charges, &c., £4,540; making a total of £226,270. The estimated expenditure is for generation and distribution costs, management expenses, rates, taxes, &c., £91,320; maintenance and repairs to public lamps and repairs to properties, £4,500; allowances to employés, £4,500; sales department, £10,250; repayment of loans, £47,303; interest, £66,576; making a total of £224,449, and leaving an estimated credit balance on the year's working of £1,821.

The Electricity Committee recommends that two underfeed stokers be fitted to two additional boilers, at a cost of £2,100; it also reports that alterations have been made at Aybrook Street sub-station, at an estimated cost of £750.

The report of the working of the electricity department for the December quarter shows that 5,341,237 units were sold, representing a net increase of 7·2 per cent. over December, 1915. The net revenue from the sale of electricity and meter rentals totalled £63,252, being an increase over December, 1915, of £2,783. The total expenditure for the quarter amounted to £23,383, an increase as compared with the December quarter of 1915 of £3,747. The total average costs per unit sold were 1·141d., as against 1·042d. The result of the quarter's working shows a net improvement of the balance available for capital charges of £895, making a total for the nine months of £75,721.

Mytholmroyd (Yorkshire).—The U.D.C., last week, agreed to the Halifax Corporation applying to the B. of T. for an Order authorising it to supply electricity to several industrial concerns at Mytholmroyd, conditional on it undertaking to discontinue the supply on written request by the Mytholmroyd Council, and on there being no liability attached for any cost or expense incurred by the Corporation.

Rochdale.—The D. R. Cotton Co., Sudden, has written to the Corporation Electricity Committee, asking if the department is in a position to give it the full supply of energy promised—between 1,700 and 1,800 kw. The Committee has replied that it cannot supply more than 1,350 kw. at present.

South Africa.—The Johannesburg T.C. recently decided that no applications for electric light or power connections could be entertained after February 19th and until further power was available. The turbines ordered in England with this object cannot be delivered for a considerable time.

Swansea.—Linking-up.—The engineer has attended a meeting with regard to interconnection of electric supply undertakings; as regards the question of funds for the preparation of plants, reports, &c., each undertaking, it is proposed, shall guarantee a maximum amount of 1½ guineas per £10,000 of gross revenue.

Tasmania.—According to *Tenders*, Mr. J. H. Butters, general manager of the Government Hydro-Electric Department, has informed the Launceston City Council that it will not be possible to complete the extensions to the Great Lake scheme for 18 months, owing to the impossibility of obtaining the material in England; consequently, the negotiations for the supply of energy have been suspended. Mr. Butters suggests that it might be possible to limit the demand, with a view to avoiding extensions of plant in the meantime.

TRAMWAY and RAILWAY NOTES.

Accrington.—Accident.—Considerable interference was caused to traffic on April 19th through the breaking down of the overhead equipment by the trolley poles of two cars getting into contact. The fall of the equipment resulted in the breaking of three windows in a Blackburn car, but, happily, no one was injured.

Three women are learning the work of motormen, and a woman is driving a tramcar.

Atherton.—The South Lancashire Tramways Co. is now employing women in its highway repair department.

The company has granted £100 towards the equipment of Green Hall, Atherton, as a military hospital.

Belfast.—The Tramways and Electrical Committee has recommended the pushing on of the new electric station at Hamilton Road, convenient to Belfast Lough, and also recommended a suggested revision of the stages and fares over the Corporation system of tramways. Unless this is done, the tramways will soon be bankrupt, as the war has hit them so hard that they are losing at the rate of anything from £10,000 to £15,000 per annum, and stand to lose still more in the near future should the employés persist in their demand for a further increase of pay—this time 5s. per week. These matters will be considered at the next monthly meeting of the Corporation.

Blackpool.—Record Year's Receipts.—The receipts of the Corporation tramways for the past 12 months, ended March 31st, were by far the largest on record. The total was £94,368, or over £10,000 more than the next best year, which was 1913.

Bury.—Year's Working.—The Tramways Committee reports a profit on the Bury section for the past year of £3,543, and on the Radcliffe section, under the first agreement, a loss of £452, and under the second, a loss of £406. It was decided that the profit from the undertaking and a sum of £1,456 from the reserve and depreciation fund be paid to the credit of the borough rate.

The Corporation Tramways Committee has refused the application of the Tramway and Vehicle Workers' Association for an advance in wages of 10s. per week for male and female employés in the tramway department.

Dudley.—Female Drivers.—The local Trades Council has sent a resolution to the B. of T., Ministry of Munitions, and Tramway Co. against the employment of women as tramway drivers, on the ground of physical unfitness.

Halifax.—Year's Working.—The tramway statement for the year ended March 31st shows a total income of £114,684, as compared with £113,514 in the previous year. The passenger receipts were £111,370, as against £110,130; luggage, £108, as against £149; private cars, £226, against £95; ticket vouchers and tokens, £352, against £327; parcel traffic, £1,974, as against £2,134. Advertising had cost £500, as against £441. The expenditure had been £100,125, as against £94,458, and the profit was £14,559, as against the previous year's £19,055. There had been a decrease in mileage from 2,195,980 to 2,048,772, but the number of passengers carried had increased from 21,024,003 to 21,180,584.

The figures for the week, including the Easter holidays, showed receipts £1,918, as against £1,914 last year; mileage, 35,005, as against 39,285; receipts per car-mile, 13·15d., as against 11·73d.

India.—The Government of Madras, in its review of the Madras Corporation's last report, writes that the proposals for the extension of the tramway lines in Madras City, so as to help in the removal of congestion, involve the widening of some of the bridges at considerable cost, and are still under examination.

The Municipal Commissioner of Bombay has forwarded to the Corporation for sanction the proposals submitted by the Bombay Electric Supply and Tramways Co. for extending the tramway system along Esplanade and Sandhurst Roads, and for doubling the present single track along Colaba Road.—*Indian Engineering.*

Keighley.—It was reported that meetings had been held, last week, between representatives of the Council, the Keighley Corporation Tramways Committee, and the Bingley U.D.C. with respect to the proposed linking-up of the Bradford tramways at Cross Flats, Bingley, and the Keighley tramways at Stockbridge, to which all parties were favourably inclined, but the stumbling-block is the bridge itself, which must be improved before any tramway can be run over it. The idea of an extension of the tramway track on the Bingley side, as far as Barhouse Lane, had not met with much favour, and railless extensions met with the same feeling.

Leeds.—Year's Working.—Actual figures of the past year's working of the Corporation tramways submitted to the Tramways Committee, last week, show that the receipts were £515,806, an increase of £40,301 on those of the previous year, and, for the first time in the history of the undertaking, exceeding the half-million sterling. The number of passengers carried was 112,151,883, an increase of 8,698,082, the car-mileage having been 9,658,595, an increase of 253,474 miles. The working expenses had increased by £25,259, from £236,227 to £261,486, thus leaving a gross profit of £254,231, an increase of £15,042. With the addition of bank interest and dividends on investments to the amount of £9,755, there is a disposable revenue of £264,076, of which £120,787 is for interest on capital and redemption fund instalments, £30,000 for permanent way renewals, £2,373 to go towards capital outlay; income-tax takes £18,594, and war allowances, £12,891. The surplus to relief of rates is £79,431, equal to an 8¼d. rate. Traffic expenses during the year were £122,499, the average cost per car-mile being 3·044d., as against 2·927d.; general expenses were £39,832, including £22,592 in local rates, and the cost of general repairs and maintenance was £53,291, of which £34,373 was in car repairs. Power costs were £35,098, including £12,070 for energy purchased. War bonus to employés absorbed £10,766, the wages bill, including that bonus, being £161,899.

Under the Northern Command substitution scheme, a start has been made in Leeds with the employment of wounded and discharged soldiers as drivers, about 20 of these men being now so employed, and a batch of others being in training at the depôts.

The Glasgow scheme of sale on the cars of 1d. tickets, with War Savings Certificates as prizes and about nine-tenths of the money going to war charities' funds, has, it is understood, been approved for the Leeds tramways, and a start is expected to be made very soon.

Manchester.—Year's Working.—The Corporation Tramways Committee on Tuesday decided to reduce its contribution to the city rates from £100,000 to £50,000; the increase in the rates may be 6d. in the £. The tramway revenue last year was £978,602—being £39,000 more than a year ago; the passengers numbered 219,097,258, another increase, while reduced car-miles 18,388,302—were worked. The revenue per car-mile was 12·6d. Increased costs of material, wages, &c., are reported; war service allowances and bonuses during the year are estimated to amount to £103,800.

Morecambe.—Electrification Prospects.—At the meeting of the T.C., last week, Alderman Snowden said the town's financial position was better than ever before, and they were now contemplating many improvements, one of the first of which should be the abolition of the horse cars. But for the war, they would have got a long way towards completion of the electrification scheme. The Mayor said the abolition of the horse cars would be the first step towards real progress.

Oldham.—Year's Working.—The tramway department last year made a profit in aid of the rates of £3,837. Allowances to dependents of employés serving with the Colours amounted to £5,463, and the recent war bonus granted to drivers and conductors will mean an additional expenditure of £3,456. There was a loss on the motor-'bus service of £809.

Discussing the extraordinary application for an additional bonus of 10s. a week by Lancashire tramway workers, Councillor Cheetham said it was time the authorities put their foot down; the cars, he added, were run for the convenience of the public, and not to find occupations for a number of men and women.

Rochdale.—Year's Working.—The profit on the Corporation tramways during the past year was £1,773, as compared with £3,609 a year ago, £4,284 in the previous year, and £8,489 in 1913-14. The Committee recommends the placing of the amount to the reserve fund for renewals, which now amounts to £22,000. The total receipts were £90,812, an increase of £2,904, but working expenses totalled £50,397, £2,274 more. One item—income-tax—amounted to £6,463, an increase of £2,600. These charges in 1913-14 were £1,020. A sum of £6,192 has been spent on a new car repair shed.

Salford.—At a meeting of the Local Trades and Labour Council, held last week, it was decided to protest against the raising of tramway fares by the Corporation.

South Africa.—Electric Vehicles.—After a trial of two vehicles, lasting over several months, the Johannesburg postal authorities are now using 11 such vehicles imported from America. The charging garage has been established by the importing firm, and a sliding-scale tariff has been arranged with the municipal supply authorities. According to the *S.A. Mining Journal*, as compared with the ordinary petrol car, weight for weight, the electric vehicles are run to-day at about half the cost of the ordinary petrol vehicle.

Stockport.—At a recent meeting of the T.C. the chairman of the Tramways Committee said that the present fares could not be continued if the undertaking was to hold its own. The estimates presented showed an increased expenditure for the ensuing year of £8,893, involving an increase in the rates of 3d. in the £.

Wolverhampton.—Wages.—The local branch of the Amalgamated Association of Tramway and Vehicle Workers has passed a resolution urging the Corporation to come to a final decision as regards giving increased wages, and as an alternative intimating that permission will be asked to withdraw their labour if the demands are not granted.

TELEGRAPH and TELEPHONE NOTES.

Argentina.—The Germans are putting forward a proposal to set up immediately in the Argentine a great wireless station for the receipt of messages from Berlin.

Australia.—The annual report of the Postmaster-General for 1916 shows a loss on the telegraph service of £86,426, compared with £114,555 in 1915, and a loss on the telephone service of £271,695, compared with £390,703. In September, 1915, the telephone call fees were raised from ½d. to 1d. on subscribers' lines, and from 1d. to 2d. on public call office lines, to reduce the loss.

Automatic Telephony.—On March 17th the telephone service of the Indianapolis Telephone Co. was changed over to the automatic system, with highly satisfactory results. The order was placed with the Automatic Electric Co. nine months ago, and the time occupied in completing the installation is said to make a new record. There were about 13,000 lines equipped at the time of the change-over, and the number of subscribers is rapidly increasing.—*Telephone Engineer.*

India.—Owing to the numerous extra official demands on the telephone system in Simla, no telephones can be given to new private subscribers. The automatic system is loaded to its fullest extent, and additional connections are being made to a central battery system, which can, however, be worked in connection with the automatic. An extension of the automatic system will, it is hoped, be installed during the coming season.—*Indian Engineering.*

Morocco.—H.M. Agent and Consul-General at Tangier has forwarded an extract from the *Bulletin Officiel* of the French Zone, containing a Presidential Decree, dated December 5th, 1916, authorising the execution of certain works, at a cost of 81,000,000 fr., out of which 1,108,400 fr. are provided for telephones, and 2,293,000 fr. for telegraphs.—*Board of Trade Journal.*

Telephone Call Recorder.—An automatic recorder of effective telephone calls, invented by an Australian railway employé named Godfree, has been in use about 18 months at the Ballarat Telephone Exchange on trial, with a view to obviating the frequent complaints of overcharging. Mr. Halion, the officer in charge of the exchange, has reported that the device is giving complete satisfaction.

Wireless Installations on British Ships.—An Order in Council of April 14th gives power to the Admiralty or the Shipping Controller to require that any British ship shall forthwith be equipped with wireless telegraph apparatus, and that the crew shall be properly instructed in its use. If any ship to which such directions have been given puts to sea without complying with the Order, the owner or master will be liable to punishment, and the ship to seizure and detention.—*Board of Trade Journal.*

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—Melbourne.—May 23rd. Victorian Railways Department. Twelve months' supply (8,250) of incandescent electric lamps as ordered.*

Glasgow.—May 1st. Electricity department. 12 months' supply of cables and meters. See "Official Notices" to-day.

Manchester.—May 11th. Electricity Committee. Stuart Street generating station, (*a*) one hydraulic accumulator and electrically driven ram pump, (*b*) coal conveying plant. Mr. F. E. Hughes, Secretary, Electricity Department.

Sheffield.—May 8th. Tramways and Motors Committee. Carbon-filament lamps for tramcar lighting, for 12 months. See "Official Notices" to-day.

Wigan.—May 5th. Corporation electricity works. Best quick-firing slack or washed peas, for a year. Electrical Engineer, Bradford Place.

* Specifications may be seen at the Department of Commercial Intelligence, 73, Basinghall Street, London, E.C.

Wolverhampton.—May 4th. Electricity Committee. 5,000-kw. turbo-alternator, water-tube boilers, economisers, and induced-draught plant, and mechanical stokers. See "Official Notices" to-day.

CLOSED.

Dover.—T.C. Coal for the electricity works:—3,000 tons of Featherstone coal, at 26s. 5d. per ton; 2,000 tons of Snowdown nuts, at 26s. 6d. per ton.

Government Contracts.—List of new contracts placed during March, 1917:—

War Office.

Bridge meggers.—Evershed & Vignoles, Ltd.
Electric cable and wire.—British Insulated & Helsby Cables, Ltd.; Callender's Cable and Construction Co., Ltd.; Connolly Bros., Ltd.; Craig Park Electric Cable Co., Ltd; I. Frankenburg & Sons, Ltd.; General Electric Co., Ltd.; W. T. Glover & Co., Ltd.; W. T. Henley's Telegraph Works Co., Ltd.; Hooper's Telegraph and India-Rubber Works, Ltd.; India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.; Johnson & Phillips, Ltd.; Liverpool Electric Cable Co., Ltd.; C. Macintosh & Co., Ltd.; St. Helens Cable & Rubber Co., Ltd.
Telephone cords.—London Electric Wire Co. & Smith's, Ltd.; C. A. Vandervell & Co.
Insulator cups and caps.—Litholite, Ltd.
Distribution boards.—Kartret Engineering Co.
Electric light fittings.—Bullers, Ltd.; Electric and Ordnance Accessories Co., Ltd.; Gutherie & Co.; W. Kent; J. Macintyre & Co., Ltd.; E. Stevens, Ltd.; J. Stevens, Ltd.
Generating sets.—A. Lyon & Wrench, Ltd.; Smart & Brown.
Electric lamps.—British Thomson-Houston Co., Ltd.; Edison Swan Electric Co., Ltd.; General Electric Co., Ltd.; Siemens Bros. Dynamo Works, Ltd.
Switches.—Kerr, Stuart & Co., Ltd.; W. Sanders & Co.; Sperryn & Co., Ltd.; Wandsworth Electrical Mfg. Co., Ltd.; W. White & Co., Ltd.
Electrical terminals, &c.—Automatic Standard Screw Co., Ltd.; Davis and Timmins, Ltd.; Croggon & Co., Ltd.; F. Giles & Sons; L. Herve; Houghton-Butcher Manufacturing Co., Ltd.; Ingram & Kemp, Ltd.; Sperryn & Co., Ltd.; C. J. Thursfield & Co.
Iron and steel wire.—Dorman, Long & Co., Ltd.; Rylands Bros., Ltd.; Shropshire Iron Co., Ltd.; R. Johnson & Nephew, Ltd.
Tinned copper wire.—Liverpool Electric Cable Co., Ltd.
Works services.—Electric lighting, Cecil Cooper & Co.; installation of electric light, H. J. Cash & Co.; erection of boilers, Babcock and Wilcox, Ltd.

India Office Store Department.

Brackets.—Bullers, Ltd.
Cable.—Callender's Cable Co., Ltd.
Cells.—Siemens Bros. & Co., Ltd.
Dynamo.—Lancashire Dynamo, &c., Co.
Insulators.—Bullers, Ltd.; Taylor, Tunnicliff & Co.
Telephones.—Peel-Conner Telephone Works, Ltd.
Wire.—T. Bolton & Sons; F. Smith & Co.; Dorman, Long & Co.; R. Johnson & Nephew; Rylands Bros.; Shropshire Iron Co.

Post Office.

Telephone apparatus.—British L. M. Ericsson Manufacturing Co., Ltd.; Peel-Conner Telephone Works, Ltd.; Walter's Electrical Manufacturing Co., Ltd.; Western Electric Co., Ltd.
Arm grips for poles.—Bayliss, Jones & Bayliss, Ltd.
Wood arms.—British Australian Timber Co., Ltd.; T. Gabriel & Sons and Burton; W. F. Holloway & Bros.
Bodies and covers for insulators.—Taylor, Tunnicliff & Co., Ltd.
Submarine cable.—Telegraph Construction and Maintenance Co., Ltd.
Telegraph cable.—British Insulated & Helsby Cables, Ltd.; Henley's Telegraph Works Co., Ltd.; Johnson & Phillips, Ltd.; St. Helens Cable and Rubber Co., Ltd.; Telegraph Construction and Maintenance Co., Ltd.; Union Cable Co., Ltd.
Telephone cable.—Peel-Conner Telephone Works, Ltd.; Western Electric Co., Ltd.
Telephone cords.—B. I. & Helsby Cables, Ltd.; Western Electric Co., Ltd.
Wire drums.—Siemens Bros. & Co., Ltd.
Telephone mouthpieces.—Crystalate Manufacturing Co., Ltd.
Insulator spindles.—Bullers, Ltd.
Telephones.—Peel-Conner Telephone Works, Ltd.
Bronze wire.—Shropshire Iron Co., Ltd.

Commissioners of Public Works, Ireland.

Electrical works and supplies.—J. F. Keatinge & Sons.

Hull.—The Electricity Committee has accepted the offer of Messrs. Priestman for a grab for the loading of coal, ashes, &c., at a cost of £1,800.

London.—Marylebone.—The Electricity Committee has accepted an offer from Messrs. A. Blackmore & Co. for the supply of 1,000/1,200 tons Granville 1½-in. nutty slack.

The Committee recommends the acceptance of the following tenders:—Two additional mechanical stokers, £1,809, Underfeed Stoker Co.; 22,000 tons of coke breeze, delivered into truck or barge at gas works, 8s. per ton, Gas Light and Coke Co.

FORTHCOMING EVENTS.

Physical Society of London.—Friday, April 27th. At 5 p.m. At the Royal College of Science, Exhibition Road, South Kensington, S.W. Ordinary meeting.

Royal Society of Arts.—Monday, April 30th. At 4.30 p.m. At John Street, Adelphi, W.C. Howard Lecture, "The National Shortage of Iron Ore Supplies—Available Home Supplies of Iron Ore," by Prof. W. G. Fearnsides.

Faraday Society.—Tuesday, May 1st. At Burlington House, Piccadilly, W. At 8 p.m. Discussion on "Osmotic Pressure." To be opened by Prof A. W. Porter, F.R.S.

Roentgen Society.—Tuesday, May 1st. At the Cancer Hospital, Fulham Road, S.W. At 8.15 p.m. Discussion (continued) on "The Future of the British X-ray Industry."

Institution of Civil Engineers.—Wednesday, May 2nd. At 5.30 p.m. At Great George Street, S.W. James Forrest Lecture on "The Standardisation of Engineering Materials, and its Influence on the Prosperity of the Country," by Sir John Wolfe Barry, K.C.B., F.R.S.

Institute of Metals.—Thursday, May 3rd. At 8.30 p.m. At the Institution of Civil Engineers, Great George Street, S.W. Lecture on "Researches made Possible by the Autographic Load-Extension Optical Indicator," by Prof. W. E. Dalby, F.R.S.

Junior Institution of Engineers.—Friday, May 4th. At 7.30 p.m. At 39, Victoria Street, S.W. Paper on "Pneumatic Tubes," by Mr. H. E. Cosgreave.

Royal Institution of Great Britain.—Saturday, May 5th. At 3 p.m. At Albemarle Street, Piccadilly, W. Lecture on "The Electrical Properties of Gases," by Prof. Sir J. J. Thomson, Pres.R.S.

NOTES.

Earth-to-Air Discharges and Fire Risks.—We have received a shoal of cuttings from the *Manchester Guardian* of April 17th, regarding a recent fire in Manchester, and are much indebted to our various correspondents. The following is the item which has aroused so much interest:—

"The Portland Street Fire.—'F. J.' writes from Manchester:—I suggest that the cause of this fire, and of others like it, may be found in the metal conduits—water, hydraulic, and gas mains—which conduct the earth electricity inside the buildings until it reaches the upper storeys. Here a resistance is met with, as the conduits are smaller. This resistance produces heat, and thus sets fire to any inflammable material. If the conduits are sufficient in electrical carrying capacity to conduct the earth electricity silently inside the building until it reaches the upper storeys, it discharges itself through the roof into the air, and, of course, sets fire to neighbouring inflammable material. It is definitely known that a large building in this area was set on fire by earth-to-air electrical discharge. The conflagration was discovered immediately, and the actual cause was evident. Had this occurred when there was nobody on the premises, the origin would not have been discovered. This instance was not made public. None of these warehouses was protected from either earth-to-air or air-to-earth electrical discharges. It is interesting to note that no big fire has occurred in Manchester where provision has been made for these discharges by the erection of lightning conductors, which form a permanently effective means for silently discharging highly charged areas of earth or clouds."

One of our correspondents—Mr. G. L. Enderby—satirically inquires whether, in view of the high price of electrical energy, our readers will kindly put forward suggestions for the utilisation of this valuable source of electricity to light a few lamps in the upper stories of tall buildings. We fear, however, that such hopes are doomed to disappointment. We do not know who "F. J." is, or where he acquired his profound insight into atmospheric electrical phenomena, but we could suggest other initials which would be more appropriate.

American Electrical Industry and the War.—Under the title "Electrical Industries Ready to Serve," the *Electrical World*, U.S., publishes appropriate messages from leaders of these industries, the writers being Mr. E. W. Rice, jun., president of the General Electric Co.; Mr. S. S. Wheeler, president of the Crocker-Wheeler Co.; Mr. H. W. Buck, president of the American Institute of Electrical Engineers; and Mr. H. A. Wagner, president of the National Electric Light Association. The letter from Mr. Rice reads as follows:—

"The Industry's Pledge.

"To the *Electrical World*.

"The President's message expresses in simple but powerful words the solemn and final judgment of a great peace-loving people on the issues of this great war.

"While every thoughtful citizen must realise the gravity of the step which we are now taking, there will be no holding back, and no matter what trials the future may have for us, the knowledge that we are fighting in defence of all that makes life worth living will enable us to persevere until victory for ourselves and our natural allies has been obtained.

"Men of the electrical industry, representing every phase of scientific and engineering activity, will be able to render invaluable service, as a modern war, as is well known, cannot be won by courage and strength alone, but demands skill in control of complicated machinery and the use of scientific methods all the time and everywhere.

"This is not a war between peoples, but a mighty conflict of irreconcilable ideals of government and of life, and there can be no question, therefore, that every citizen of this country who treasures our ideals will welcome the solemn privilege, which has been forced upon him, of fighting for them. We all devoutly hope and believe that the entrance of our nation on the side of liberty and humanity will bring to a speedy end this terrible scourge of the world.

"E. W. Rice, jun.

"Schenectady, *April 4th*, 1917."

Restriction of Sunday Labour.—According to the *Daily Telegraph*, Sunday labour is, as far as possible, to be abolished in a large majority of the establishments controlled by the Ministry of Munitions, from the beginning of May. Establishments in which the process worked is of necessity of a continuous nature will not come within the operation of the new order, and an exception will also be made in the case of firms whose contracts are of great urgency.

The abolition of continuous Sunday labour in the national factories and in controlled establishments has, in most cases, been highly beneficial, as would be anticipated in view of the results of investigations noted in our pages, which showed that a suitable division of time between labour and rest diminished fatigue and increased output. Long working hours do not pay.

That Sunday labour has a pernicious effect on the health of workers, particularly in heavy trades, says the *Times*, is one of the conclusions of an interim report on Industrial Efficiency and Fatigue, which has just been issued by the Health of Munition Workers' Committee. The report contains certain memoranda which have already been published, but much of it is a record of new and important work. The investigations of Prof. Loveday on

the incidence and causation of lost time reveal the fact that insufficient allowance is generally made for the extent to which lost time is caused by sickness, partly owing to the difficulty of obtaining reliable medical certificates. Except when hours have been very long, relatively to the class of work, evidence is lacking of an increase of sickness. On the other hand, the hours gained by overtime may be lost, to a large extent, by lost time. Prof. Lovedav suggests reasons for the opinion that the employment of workers before breakfast is uneconomical and unprofitable. In regard to "staleness," a single day off given occasionally, at the right time, would, it is suggested, have avoided much wasteful reduction of capacity, and, in the worst cases, the total loss of many days of work.

Volunteer Notes.—First London Engineer Volunteers.—Headquarters: Balderton Street, Oxford Street, W.

Orders for the Week, by Lieut.-Colonel Clay, V.D., Commanding:—

Monday, April 30th.—Technical for No. 3 Company, Right Half Company, at Regency Street. Drill No. 3 Company, Left Half Company. Signalling Class. Recruits' Drill, 6.30—8. Medical examination and attestation, 6—8.

Tuesday, May 1st.—Lecture, "Demonstration of Landscape Target," by Platoon Sergeant Hoad, 6.30. Physical drill and bayonet fighting, 7.30 to 8.30.

Wednesday, May 2nd.—Instructional Class, 6 15. Drill No. 1 Company, Right Half Company.

Thursday, May 3rd.—Drill No. 2 Company, Right Half Company. Ambulance Class by M.O., 6.30. Signalling Class.

Friday, May 4th.—Technical for No. 3 Company, Left Half Company, Regency Street. Drill No. 3 Company, Right Half Company. Recruits' Drill, 6.30—8.30.

Saturday, May 5th.—Commandant's Parade, 2.45. Uniform, for drill in Hyde Park.

Sunday, May 6th.—Special work at Bombing School. Parade, Clapham Common Station (City and S.L. Railway), Tube, 9.45 a.m.

(By order), Macleod Yearsley, *Captain and Adjutant.*

Metropolitan Association of Electric Tramway Managers.—A meeting of the members of this Association was held at the Municipal and County Club, Whitehall Court. Whitehall, S.W., last Friday, when there were present:—Messrs. Ullmann (East Ham), chairman; Hammond (M.E.T.), vice-chairman; Bruce (L.C.C.), Harvey (Ilford), Mason (South Met.), Mackinnon (London United), and Goodyer (Croydon), hon. sec. Letters of inability to attend were received from Messrs. Murray (Walthamstow), Slattery (West Ham), Williams (Erith), Stokes (Bexley Heath), and Schofield (Leyton). Various matters of interest were discussed.

Manchester Engineers' Wages.—The pieceworkers in the engineering trade in the Manchester district have received notice that the Government Production Committee has awarded them an advance of 7½ per cent. for the period of abnormal conditions which have been brought about by the war. The application was for a 15 per cent. advance, and originally the men were granted a 3s. a-week bonus. Against this award they appealed.—*Morning Post.*

Decimal Coinage and the Metric System.—It was announced by Mr. Bonar Law, in the House of Commons, on Monday, that Lord Balfour of Burleigh's Sub-Committee of the Reconstruction Committee on Commercial Policy is considering the question of British and Imperial weights and measures and the decimalisation of British coinage.

On Monday, the Central Chambers of Agriculture adopted a resolution in favour of a new system of weights. The report recommended that the existing legal cental of 100 lb. should be substituted for the 112-lb. cwt., 20 such centals to be the ton of 2,000 lb. It was also recommended that quotations should be given on the basis of the pound and cental, and that the Press should be urged to adopt the same basis for market quotations. Evidently the farmers will not oppose the introduction of the decimal system.

Federation of British Industries.—As a result of the deputation of representatives of the Federation of British Industries, the British Manufacturers' Association, the Central Association of Controlled Firms, and the Employers' Parliamentary Association, the following gentlemen have been appointed to form an Advisory Committee to the Ministry of Munitions, and the appointment has been approved by the Ministry:—Messrs. G. Muir Ritchie, Douglas Vickers, Geo. Terrell, M.P., R. G. Perry, H. M'Gowan, and Sir Frederick H. Smith, Bart. We shall refer further to the matter later.

The Schedule of Protected Occupations: Electrical Workers.—There is obtainable from the Government printers a Schedule of Protected Occupations (M M 130, one penny), dated April 21st, 1917, for men employed on Admiralty, War Office, or Munitions work, or in railway workshops. This is in connection with the decision of the War Cabinet that, in order that the supply of men for the Armies in the Field may be maintained, a considerable number of men fit for general service must be released. The War Service Badge Certificates and Trade Cards are to be superseded by a system which protects from recruiting men who may from time to time be found indispensable. The schedule shows the age above which workers are protected for the present; but if the needs of the Army again become urgent, the arrangements may be modified. Electricians may be called up below the age of 23, but electrical fitters of all ages are protected. In instrument making, all electricians on medical apparatus are protected, whatever their ages. In scientific and electrical instrument making, there is protection for all ages of men making scientific instruments and wireless telegraph instruments, while the age of 23 is fixed as the limit for protection of "electrical instrument makers." In X-ray apparatus manufacture, there is protection for coil makers and pumpers of all ages, but for photographic-plate makers (including chemists) the age is fixed at 23. Skilled men of all ages in the manufacture of electrical insulating material and electrical wire and cable are protected, as are a number of classes of men engaged in electrical accumulator manufacture, though departmental managers or foremen are protected above 25 only. Skilled workmen only, engaged in electric lamp manufacture, are protected at all ages. The entry respecting electrical generating stations is as follows:—

Station and sub-station engineers, switchboard attendants, shift engineers, cable jointers, age 23. Electrical generating stations include those for tramway undertakings in cases where the undertakings are certified by the Ministry of Munitions under the Munitions of War Act. Other workmen employed by certain electrical undertakings are to be as and if specified in the "Engineering" Section of the Schedule. Under Professional occupations, electrical engineers are protected above the age of 23.

Institution and Lecture Notes.—Institution of Electrical Engineers.—The report of the Committee of the Birmingham Local Section was presented to the annual general meeting on Wednesday last. It stated that the average attendance at meetings was 46, compared with 43 in the previous session. The membership showed a net decrease of four members. The following are the office-bearers and Committee for 1917-18:—

Chairman.—S. T. Allen.

Vice-Chairmen.—N. B. Rosher; C. C. Garrard, Ph.D.

Ordinary Members of Committee:—F. H. Clough, F. Forrest, W. H. Heaton, E. J. Kipps, W. A. Jackson, S. James, W. Marden, A. Pearson, T. Plummer, W. E. Sumpner, D.Sc., F. Thursfield, E. O. Turner, and J. M. Walshe.

Honorary Secretary.—J. D. Morgan.

We understand that, acting under Article 30, some 36 gentlemen, many of them very well known in the electrical world, have sent in the nomination of Mr. Gerald W. Partridge, for the office of vice-president of the Institution.

Institution of Civil Engineers.—At the annual general meeting on April 17th, the result of the ballot for the election of officers was declared as follows:—President, Mr. W. B. Worthington; vice-presidents, Mr. J. A. F. Aspinall, Mr. H. E. Jones, Sir John P. Griffith, and Mr. J. A. Brodie. Other members of Council include Dr. Dugald Clerk, F.R.S., Colonel R. E. B. Crompton, C.B., Sir Robert A. Hadfield, F.R.S., Prof. Bertram Hopkinson, C.M.G., F.R.S., Dr. W. H. Maw, Mr. Basil Mott, Capt. H. P. R. Sankey, C.B., and Sir John F. C. Snell.

S.A. Institute of Electrical Engineers.—In his presidential address, Mr. W. H. Perrow took the induction coil as his text, and reviewed its early history, subsequent development, and some of its applications.

Faraday House Scholarships.—As a result of the Scholarship Examinations held at Faraday House Electrical Engineering College, Southampton Row, London, W.C., this month, the following awards have been made by the Governors of the College:—To John Arnold Gundry (St. Bees School), a Faraday Scholarship of 50 guineas per annum, tenable for three years; to Arthur Leslie Long (Hertford Grammar School), a Maxwell Scholarship of 50 guineas per annum, tenable for two years; to Harold Charles Reeves (County School, Wood Green), an Exhibition of 30 guineas per annum, tenable for three years; to Eric Gledhill (County School, Fishguard), an Exhibition of 30 guineas per annum, tenable for three years; to Cecil Corbin (the Philological School, Southsea), a Special Prize of 25 guineas.

The Colonial Premiers.—On Tuesday afternoon, at Stationers' Hall, the British Manufacturers' Association, 1915, gave a reception to the Colonial Premiers. The address of welcome was given by Mr. George Terrell, M.P., chairman of the Association, which has a membership of 700 firms engaged in practically every branch of manufacture. He explained that one of the main purposes of the Association was to foster better trading relations with the Dominions and Colonies, while another was to arrive at a better understanding with the employés. Their members were prepared to make any necessary sacrifices for the successful prosecution of the war, and after the war they would do all that lay in their power to prevent the Huns from coming back here to overrun the country as in the past. They must also prepare for the gap of many months which was certain to occur between the stoppage of the manufacture of munitions and the resumption of normal manufacturing. Unrest was always certain in times of unemployment, and the Association urged the Government to be ready with a policy of reconstruction, a policy of protection for British trade, and a policy of consolidation of the Empire on the basis of preferential trade. Sir Edward Morris, Prime Minister of Newfoundland, responded, and in doing so, referred to certain after-the-war problems. Thorough organisation was necessary in order that we could deal with them aright. The Kaiser had done more than any man before him to bring about the unity of the British Empire.

American Help for British Engineers.—We read in the American *Electrical Review* that a Committee of representative American engineers, including a very large percentage of prominent electrical men throughout the country, has issued an appeal to the members of the engineering profession in the United States to contribute to a fund for the relief of the families of engineers in Great Britain who are experiencing serious privation. Mr. Lewis B. Stillwell is acting as treasurer and receiving subscriptions.

Appointments Vacant.—The Cape Town City Council has been inviting applications for the position of city electrical engineer, at a commencing salary of £1,000 per annum; applications have to be received by the town clerk by May 15th.

Chief assistant, two maintenance engineers, two switchmen and sub-station supervisors, and two stokers, for the Oxford Electricity Co., Ltd.; shift engineer for the Stepney B.C. Electricity Works; shift engineer (42s.) for the Queen Mary's Military Hospital, Whalley; two shift engineers for the Batley Corporation Electricity Works. See our advertisement pages to-day.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station and Tramway Officials.—Mr. J. E. PEARCE, engineer-in-charge at the Hammersmith B.C. electricity works, has been granted a commission as Lieutenant in the Royal Engineers. Mr. H. R. WATTS, meter superintendent, has been granted a commission as Lieutenant in the Royal Garrison Artillery.

Southport T.C. has increased the salary of Mr. T. J. KENDREW, the borough tramways manager, by £50 to £300. Ald. Griffiths said there was not an undertaking of similar size and importance where a manager received so low a salary.

The Lancaster Electricity Committee has agreed to pay a bonus of £75 to Mr. J. B. PATTERSON, acting electrical engineer, for extra services during the absence of Major E. C. Milnes.

General.—Mr. A. W. BUSH has resigned his position in the Sheffield Corporation electricity supply department, and has joined Messrs. Marsh Bros. (electricians), Ltd., of Sheffield, as their representative.

Mr. A. H. DESFORGES, who has been in the employ of Messrs. Siemens Bros. & Co., Ltd., Woolwich, for nearly 20 years, has been gazetted as a Temporary Second-Lieutenant on probation as Equipment Officer, Royal Flying Corps.

At Stoke-on-Trent, on April 17th, the marriage took place of Mr. HENRY BEDSON, A.M.I.E.E., of London, to Miss Rosalie Newton.

Roll of Honour.—Captain A. N. DRYSDALE, M.C., Highland Light Infantry, a director of Messrs. Drysdale & Co., Ltd., "Bon-Accord" Works, Glasgow, died on April 15th, at a casualty clearing station in France, from wounds received in action on April 1st.

Private STANLEY SPURGEON, Essex Regiment, who has fallen in action whilst serving with the Egyptian Expeditionary Force, was with Messrs. Crompton & Co., Ltd., of Chelmsford.

The Military Medal for bravery at the Front during an air raid has been awarded to Bombardier GEO. BASS, R.G.A., who enlisted from the Dover Corporation tramway staff.

Private W. KIRBY, Royal Warwickshire Regiment, who is reported killed, after being missing since July 1st last, was with the Rugby works of the B.T.H. Co., Ltd.

Third Air Mechanic M. BRUCE, who joined the R.F.C. only three weeks ago, whilst with the B.T.H. Co., Ltd., of Rugby, has died from illness at a military camp.

Private W. PODMORE, North Staffs. Regiment, who was with Messrs. Taylor & Tunnicliffe, of Hanley, has been killed in action.

Gunner GEORGE LEWIS, Salford, of the R.G.A., who has died of wounds, was employed at the British Westinghouse Works, at Trafford Park.

Private TOM YATES, of Stretford, Royal Berkshire Regiment (late Northants Regiment), who was formerly in the employ of Messrs. W. T. Glover & Co., Ltd., Trafford Park, is reported to have been killed on April 4th.

The *Times* states that Lieutenant GEORGE LAURENCE FORBES MACKAY, Leinster Regiment (Royal Canadians), attached to a Signal Company, R.E., died on April 12th, aged 19, of wounds received whilst supervising the mending of a buried cable.

Obituary.—MR. GEORGE G. WARD.—It is with regret we have to record the death from heart failure of Mr. George G. Ward, deputy-chairman of Messrs. Davidson & Co., Belfast, which occurred suddenly on Tuesday morning at his residence at Craigavad. Mr. Ward, who was 56 years of age, was at business last Saturday, and was in his usual health on Sunday, but was suddenly taken ill during the night. He was the eldest surviving son of the late Mr. F. D. Ward, and began his business career with the well-known firm of Marcus Ward & Co., where he served his time, and eventually held a prominent position. He joined the Sirocco Works 21 years ago, and was appointed a director when the company became a limited concern in 1898. A good business man, an energetic worker, he loyally supported Mr. S. C. Davidson, whose lifelong friend he was, during the many years of their close association, and contributed in no small measure to the success of the firm, not sparing himself in any way, and more especially since the outbreak of the war, when the absence of two co-directors at the Front greatly increased the work and responsibility of the remaining directors. Mr. Ward was a genial man of very kindly disposition, whose loss will be sincerely mourned by his many personal and business friends. The greatest sympathy is felt for Mrs. Ward in her bereavement.

MR. ALWYN WALTER STAVELEY.—We regret to report the death of Mr. A. W. Staveley, of the firm of Messrs. Gent and Co., Ltd., Leicester, which occurred suddenly on Monday morning last, at his residence in Redcliffe Road, Nottingham, at the age of 58 years. Mr. Staveley was at the works up to mid-day on Saturday, and appeared in his usual good health, but a sudden attack of illness during the week-end caused his decease through heart failure. Mr. Staveley joined the late Mr. J. T. Gent in 1880, and took an active part in the management of a growing business. When the firm was eventually formed into a limited company, he took the position of senior director, and continued this office up to the time of his death.

MR. FERDINAND W. ROEBLING.—Mr. F. W. Roebling, treasurer and managing director of John A. Roebling's Sons Co., died on March 16th, at Trenton, N.J., aged 75. His father was the founder of the business.

MR. RANKIN KENNEDY.—We deeply regret to record the death of an old friend, Mr. Rankin Kennedy, who, in his earlier years, when his interests were more directly electrical than they have recently been, was a frequent contributor to the pages of the ELECTRICAL REVIEW.

DR. W. GOULD RHODES.—We regret to announce the death, after a prolonged illness, of Dr. W. G. Rhodes, at Manchester. His scientific training was acquired at Owens College (Victoria University), Manchester, where his remarkable mathematical gifts were developed, and he attained the degree of M.Sc. (later proceeding to the Doctorate). Coming to London, he spent some years at the Central Technical College as demonstrator and lecturer in physics and electrical engineering under Prof. Ayrton, and contributed numerous articles to our pages. In 1896 Mr. Rhodes took up the position of chief lecturer in electrical engineering at the Royal Technical Institute, Salford, with which he was connected for many years, eventually becoming head of the electrical engineering department. He also developed a private consulting practice; in conjunction with Mr. J. M. Hewitt he was consulting engineer to the Llandudno & Colwyn Bay Electric Traction Co., and undertook an interesting investigation of the Belgian system of light railways. He was the author of a number of technical papers and books on alternating currents. Both as a valued contributor and as a personal friend of long standing, he stood high in our esteem, and many of our readers will share our sorrow at his early death. He leaves a widow and one son.

MR. R. H. BURNHAM.—Mr. Richard Henry Burnham, late telegraph superintendent to the S.E. & C. Railway, passed away at Norwood, on April 24th, aged 71 years.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

J. Stone & Co., Ltd.—Debenture dated April 4th, 1917, to secure £100,000 charged on the company's undertaking and property, present and future, including uncalled capital. Holders: London County and Westminster Bank.

Chelsea Electricity Supply Co., Ltd.—A memorandum of satisfaction to the extent of £53,212 on December 13th, 1916, of debenture stock created March 6th, 1895, securing sums to the nominal amount of the share capital.

Rawlings Bros., Ltd.—A memorandum of satisfaction on April 4th, 1917, of debenture dated March 16th, 1909, securing £200, has been filed.

Harpin & Co., Ltd. (109,290).—Capital, £2,500 in £1 shares (1,500 pref. and 1,000 ord.). Return dated March 12th, 1917. 775 pref. and 727 ord. shares taken up; £977 paid; £525 considered as paid. Mortgages and charges: Nil.

Clarke, Chapman & Co., Ltd. (39,045).—Capital, £250,000 in 18,000 ord. and 7,000 pref. shares of £10 each. Return dated March 16th, 1917. 15,281 ord. and 6,985 pref. shares taken up; £10 per share called up on 3,536 ord., £2 10s. on 200 ord., and £10 on 4,435 pref.; £80,210 paid; £142,450 considered as paid, being £10 per share on 11,545 ord. and 2,550 pref., and £7 10s. per share on 200 ord. Mortgages and charges: £100,000.

British Mica Co., Ltd. (72,187).—Capital, £5,000 in 2,000 pref. and 3,000 ord. shares of £1 each. Return dated December 17th, 1901. 785 pref. and 2,194 ord. shares taken up; £979 paid; £2,000 considered as paid. Mortgages and charges: Nil.

CITY NOTES.

Western Electric Co. (U.S.A.)

The report for 1916 shows a remarkable increase in gross sales. They jumped last year from $63,852,469 to $106,986,677, a gain of 62 per cent. The orders on hand December 31st, 1916, were $22,028,000 in value more than on December 31st, 1915. The report states that manufacturing

conditions in America during the year have been extremely difficult. It has been almost impossible to provide a regular supply of material, not only on account of the general shortage, but also on account of the uncertainties of freight transportation. The demand for products increased very rapidly during the year, and the necessity of meeting this demand has taxed all available resources for machinery, tools, and other expense items. The detailed earnings report for the year 1916 is as follows:—

Sales	$106,986,677
Other income	1,229,636
Total income	108,216,313
Cost of merchandise	95,936,433
Expenses	7,014,254
Taxes	587,050
Special payments to employés	973,866
Reserve for contingencies	500,000
Available for interest and dividend	3,204,710
Interest paid	880,094
Dividends	2,100,000
Carried to common stock	224,616

—*Electrical Review and Western Electrician.*

Urban Electric Supply Co., Ltd.

Mr. P. D. Tuckett presided at the annual meeting on April 11th. He said that the available net profit showed a reduction of £4,000. It was disappointing to have their progress interrupted and the preference dividend in arrear, but it would not be prudent to maintain the dividend at the expense of their slender cash resources, cumulative though the dividend was. The loss of profit was far less than might have been expected. But for the war they would have had £20,000 to dispose of that day over and above the full preference dividend, and he hoped that that would be their position a year or two hence, when they returned to more normal conditions after the war. Including the item of £328,608 due to contractors, which was subject to conversion into debentures, their total debenture debt was not far short of £800,000. This heavy burden of debt, without being a menace to the company, since he felt sure they could always rely on Edmundsons' assistance in case of need, nevertheless rendered it practically impossible for them to finance themselves independently of them except by means of resources drawn from revenue. Unless, therefore, they were to resort to Edmundsons, which they were anxious to avoid as far as possible, the annual provision for depreciation furnished the fund on which they had mainly to rely to meet current capital requirements. Last year, in spite of the very large increase in their connected load, they managed to keep their capital expenditure within the limit of their reserve provision, and before the rate of expenditure materially exceeded that figure, he hoped they would see a marked recovery in profits, enabling them substantially to increase the appropriation to reserve. Owing to the stimulus which the war had afforded to the development of the power load, their connections increased by 2,770 kw. in 1915, and last year by the record figure of 3,510 kw. These additional connections had been made without a corresponding increase in capital expenditure, with the result that in several instances they were now working with a smaller margin of plant than was altogether desirable. Under the circumstances there was nothing else to be done, since additional plant was not obtainable, but in so far as this additional load was permanent, they would sooner or later be faced with the necessity of supplementing the plant to meet it, as well as the further load which they must look forward to, and this consideration emphasised the importance of husbanding the cash resources. It remained to be seen how far the additional load connected during the past two years would be permanently retained after the war. A substantial part of it represented industrial activities directly connected with the war, which they must expect to see disappear in that form, but he hoped that many of them might survive in some other form. It was fortunate that they had in this way been able to compensate to some extent for the wholesale falling-off in the lighting load. Twickenham, with an increased power connection of nearly 2,000 kw., an increased power output of nearly 2,000,000 units, and an increased power revenue of nearly £10,000, afforded the most conspicuous example of this development, the beneficial results of which were clearly shown in the increased profit of over £3,000 which it was thereby enabled to realise. Newton Abbot had also developed a useful power load, substantially increasing its profits. On the other hand, Hawick had, in spite of an increased connection of 150 kw., dropped its profit to within £150 of the figure at which it stood two years ago, the mills, which were working day and night on large Government orders at the beginning of the war, having this last year become comparatively slack. Grantham again showed a gratifying increase of profit, no less than 140 per cent. during the past three years, until it now represented a return of over 11 per cent. on the capital; but whether these results would be maintained after the war must largely depend on circumstances. Grantham was the only undertaking whose lighting load had increased during the past year. In all the others there had been a very marked and serious decrease, amounting in the aggregate to 554,000 units, and it was this decrease, combined with the heavy increase in cost, which had produced the poor results shown by most of them. The principal causes which had operated to reduce the lighting load were the Summer Time Act, from which they had suffered severely, the more drastic lighting restrictions, and the general appeal for economy in the use of electric light based on the entirely erroneous belief that a corresponding saving of coal was thereby effected. In the case of a gas undertaking, reduced output to a large extent represented reduced coal consumption, whereas their plant had to be run, and approximately the same amount of coal was burned, whether the daily output was 1,000 or 1,100 units. That was one of the reasons why their profits were so seriously affected when the output and resulting revenue fell, and why they tended to be correspondingly increased when the output and revenue expanded. Of the increased costs, by far the largest item was represented by coal, the increased price of which accounted for an increased cost of over £13,000 as compared with 1915, and of over £23,000 as compared with 1914, in addition to which the quality had generally been inferior to that of similar class coal prior to the war. Increased wages, war allowances to the dependents of men on active service, and aircraft insurance accounted approximately for a further £2,000. Altogether 225 of their men had been called up, and eight of them had been killed. In connection with the aircraft insurance, he invited them to share the responsibility which they had taken upon themselves in refraining from covering the stations in Devonshire and Cornwall. It appeared that the risk of damage in their case was so remote that they were justified in exercising their discretion to save the company the cost of their insurance, which would have amounted to over £100. The sum involved was not large, but in these times every pound was of importance. In order to meet the increased costs they had further increased the rates of charge, until they were now, in most cases, as high as they were able to raise them. Indeed, in three of the undertakings they had, with the Board of Trade's approval, raised them above the legal maximum. It was always difficult to forecast the effect of increased rates, because they were liable to be partially offset by reduced consumption, but they hoped that the increases which they had made would compensate them for any increased costs to which they might be put this year. After alluding to the disorganisation of the staff consequent upon the demands of military service, the chairman gave a tabulated record of the financial results realised during the past nine years. The steady progress disclosed was calculated to reassure them, should they be inclined to feel somewhat discouraged by the exceptional difficulties of these exceptional times. In regard to the current year's prospects, it was impossible to form any reliable estimate, so abnormal were the conditions. They were doing all they could to minimise their adverse effects, but they were powerless to overcome them, and as long as the war lasted he was afraid they could expect no material relief. Whatever fate this year might have in store for them, they had every justification for anticipating that soon after the war was over they would see a marked expansion in their profits.

Johnson and Phillips, Ltd.

The profit on trading accounts, &c., for 1916, after making provision for bad and doubtful debts, and after charging to revenue upwards of £8,000 for maintenance of buildings, plant, &c., amounts to £56,061, plus £34,050 brought forward (less £8,750 for dividend paid May, 1916), making £81,361, which is dealt with as follows:—Remuneration of directors, &c., £1,897; debenture stock interest, £5,345; debenture sinking fund reserve, £7,557; second debenture interest, £2,500; depreciation on machinery and plant, &c., £12,139; interest on loan, £1,709; reserve account, £10,000; income-tax and excess profits duty, £8,928; written off patents, £2,575; special reserve account, £10,000; dividend of 5 per cent., free of tax, on the ordinary shares, £8,750; carrying forward £9,961. The above transfers to reserve and special reserve are to meet contingencies in connection with the war. Annual meeting: April 26th.

Amalgamated Wireless (Australasia) Ltd.

The report for the six months ended December 31st shows a net profit of £4,540, which, with £1,023 brought forward, makes £5,563 at credit of profit and loss, which the directors propose to carry forward. Trading is still seriously interfered with by the war. The ships' message traffic shows considerable fluctuations, owing to war regulations. Subsidy ships have increased to 97. The following comparison is made in the *Sydney Morning Herald*:—

	Half-year ended		
	Dec. 31, 1914.	Dec. 31, 1915.	Dec. 31, 1916.
Net profit	£7,812	£2,229	£4,540
Dividend per cent.	5*	—	—
Amount of dividend	3,500	—	—
Carried forward	4,312	3,331	5,563

* Per annum.

At the half-yearly meeting, on March 1st, Mr. H. R. Denison said that, in spite of the difficulties of the war, business had been extremely well maintained. They practically had control of the whole of the maritime wireless over the coasts of Australia and New Zealand. All the coastal steamers, together with those trading from the old country, were on their register, and had been equipped by the com-

pany with their ship's stations. There were 97 vessels dealing with the company, and all paid a reasonable royalty. Since the last half-yearly meeting Mr. Fisk had returned from the old country. He had arranged for three more agencies, and had opened up negotiations with manufacturing firms, which they hoped would soon prove advantageous to shareholders. They had clear rights to the Poulsen system, the only British one which had been in competition with Marconi Wireless. They were the only systems in use in the British Empire, and this placed them in a strong position. Mr. Fisk had also made such arrangements regarding the relay automatic telephone that at small expenditure the company could have a complete installation sent out for demonstration purposes, together with an engineer at the Relay Co.'s expense. He had not the slightest doubt that when the system was demonstrated they could do good business with the postal officials, because experience in other parts of the world showed that the telephone was peculiarly adapted to conditions in Australia.—*Sydney Daily Telegraph.*

W. T. Glover and Co., Ltd. The credit balance on trading for 1916 is £49,811, plus £11,701 brought forward, making £61,512. From this are deducted £1,026 for directors' fees and expenses, £7,745 for debenture interest on 4½ per cent. first and 5 per cent. second debenture stock, £4,000 transferred to trustees of second debenture stock, 5 per cent. dividend on the pref. shares £3,875, transferred to first debenture redemption fund £2,500, a dividend of 6 per cent., less income-tax, on the ordinary shares £5,340, to reserve fund £10,000, to cable maintenance reserve £5,000, leaving £22,025 to carry forward, subject to the payment of Excess Profits Duty for the two years 1915 and 1916, which cannot be ascertained at present. After making the above appropriations, the redemption fund for the first debenture stock will stand at £43,000, for the second £40,501, and the reserve at £60,000, making a total of £143,501. Many of the conditions mentioned in last year's report continue, making it still necessary to strengthen the company's reserves in order to provide further working capital. The development of the land referred to is proceeding rapidly, and will involve considerable capital expenditure in the near future.

Cuba Submarine Telegraph Co., Ltd. For 1916 the receipts were £51,747, and the expenses £15,813, plus £2,178 income-tax. The amount brought forward was £7,581, and £41,337 is available. There has been added to general reserve £14,000, and to the pension fund £2,500. Ten per cent., less income-tax, is paid on the preference shares, and 5 per cent. and a bonus of 4s. per share on the ordinary, free of tax, are recommended, carrying forward £7,637. The general reserve fund, which last year stood at £100,000, has been charged with £24,000, the balance of the depreciation to date on the investments. The directors record their appreciation of the valuable services of the late Mr. George Keith rendered during 40 years. Mr. F. E. Nosworthy has been appointed director and engineer in his place. The Articles of Association are to be altered, varying the arrangement respecting directors and their fees, so as to meet the present conditions. Annual meeting: May 2nd.

River Plate Electricity Co., Ltd.—The report for 1916 states that the net revenue, after providing for administration expenses, bad debts, and depreciations, amounts to £43,558, plus £18,387 brought forward, making £61,945. The board proposes a dividend of 7 per cent. on the ordinary stock and to carry forward £18,695. Owing to the prolongation of the war no interest or amortisation payment has been received in respect of the 5 per cent. obligations of the German Trans-Oceanic Electric Co. Interest has been duly paid upon the £66,667 5 per cent. debentures of the Tucuman Tramways, Light & Power Co., Ltd., and a dividend of 4½ per cent. has also been paid upon the company's shareholding in the Argentine Electricity Co., Ltd. Trading conditions in the Province of Tucuman, and also in the Province of Santiago del Estero, where the Argentine Electricity Co. operates, are still most unfavourable, and the outlook is uncertain.—*Financial Times.*

Montana Power Co.—The accounts for 1916 show a net income of $4,753,282, as compared with $3,167,504, and after placing $350,000, against $300,000, to reserve for depreciation, and paying dividends amounting to 3¾ per cent. on the common stock, there remained a balance of $1,339,157, increasing the total surplus brought forward to $2,399,351. Last year 2¼ per cent. was paid on the common stock. The depreciation reserve, after charging items to cover obsolescence and depreciation of equipment, and including the above sum from profits, amounted to $1,124,137 at December 31st last. —*Financial Times.*

Great Northern Telegraph Co., Ltd.—At the general meeting at Copenhagen, on May 25th, the board will propose to pay a total dividend and bonus of 24 per cent. for the year 1916, including the 5 per cent. already paid, and to transfer £83,333 to the reserve and renewal fund, £27,778 to the renewal fund for cable steamers, £55,556 to the dividend equalisation fund, and £27,778 to the pension fund. It is further proposed to set aside £111,111 for extraordinary income-taxes.

Norway.—The capital of the Stavanger Electro-Staalverk Bolag has been increased to 4,000,000 kronor (about £222,000), with the object of establishing a hydro-electric plant of about 7,000-H.P. capacity for the operation of its electric steel works. For this purpose the Ryfylke Waterfalls are to be utilised under a lease.

Direct United States Cable Co., Ltd.—The reserve fund account as at March 31st, 1917, shows a balance of £502,512, an increase of £14,807. A final dividend of 2s. per share, less tax, payable on April 30th, will make a total distribution of 4 per cent. for the year. Annual meeting: May 1st.

Evered & Co., Ltd.—The directors express regret that they are not in a position to issue accounts for 1916, as they are still under consideration by the Ministry of Munitions. The figures that have been prepared show a satisfactory result.—*Financial Times.*

Telephone Company of Egypt, Ltd.—Dividends of 6 per cent., free of income-tax, on preferred and deferred shares are announced, making 10 per cent. for year; £150,000 is put to reserve, and £87,376 is carried forward.

Birmingham District Power & Traction Co., Ltd.—The Court made an order on March 23rd confirming the reduction of capital from £1,050,000 to £700,000.

Auckland Electric Tramway Co., Ltd.—Interim dividend of 7d. per share, less income-tax, on the ordinary shares for the year ending June 30th next.

City of Buenos Aires Tramways Co. (1904), Ltd.—Dividend, 1s. 3d. per share, less tax, for the quarter ended March 31st.

Montreal Light, Heat & Power Co.—Dividend, 2 per cent. for the quarter ended April 30th, 1917.

Lima Light, Power & Tramways Co.—Dividend of 1¼ per cent., less income-tax.

STOCKS AND SHARES.

Tuesday Evening.

The near approach of the Budget is having but slight effect upon the buoyancy of the Stock Exchange markets as a whole. That the Chancellor will have heavier taxation to propose is known to be a certainty; but where the incidence will fall is a matter of guesswork (ask a smoker!). That the excess profits duty will be raised is accepted already as a foregone conclusion, but this is having little influence upon prices of shares in the companies that will be affected. The strength of the gilt-edged section is still noticeable, and the demand for industrials has spread to electric lighting shares.

The Brazilian Traction Co. provided an unpleasant surprise to its shareholders by deciding to pass the dividend for the remainder of the current year. The amount was reduced, it may be recalled, from 6 per cent. to 4 per cent; and for some time past, as the date of each announcement has approached, so the price of the shares has given way, in case further inroads were made upon the distribution. The shares, on the announcement that the directors had decided to pass the dividend, fell 4 points straight away. After touching 39, they recovered to 41½, leaving a drop of 6 on the week.

There is a good deal of speculation as to whether the shares are worth buying or not, because the company's trouble arises not from want of traffic, but by reason of the adverse exchange and what is regarded as unsound finance in the past—the piling up of liabilities without the outlook being sufficiently assured as to their being met. Time, of course, will rectify the exchange difficulty; and so long as traffics are good, a resumption of dividends is simply a matter of waiting. Upon this consideration, the price, as already noted, has recovered from the worst. The preferred fell 2 or 3 points to 82.

Of the other foreign issues, Mexicans stand out with some prominence. Mexican Light and Power bonds and certificates of deposit have risen 2-3 points during the past day or two. Other Mexicans are also better, upon vague rumours that Carranza declines to be beguiled by German blandishments. It is at any rate significant that the United States should have consented to mint for Mexico a fairly large sum of new currency; and those in this country who hold Mexican securities have noted this with pleasurable interest, not unmixed with surprise. But anticipation has so often been foiled in the past in regard to expected favourable Mexican developments that faith hesitates to put much confidence—or much money, either—into Mexicans at present; and when rises in stocks or shares take place, it is due more to sentiment than to actual business.

Reference has been made already to the improvements in electric lighting shares. County of London are good at 10½, and there are buyers about for Citys, Charing Cross, St. James's, and other London issues. Prices are not quotably advanced to any particular extent, the reason for this being that would-be buyers have no wish to put up prices against themselves, but prefer—the market being so restricted—that quotations should remain as they stand rather than that they should be raised 10s. or 15s. with no increased chance of shares being brought to market. The preference list is good also, and there is hardly any debenture stock to be had.

Underground Electric incomes continue to derive support from the opening of the Watford extension. The new line seems to have attracted already a fair measure of traffic; and, of course, is likely to receive more as time goes on. But the coming reduction in the number of 'bus services is something of a bear point in connection with the Underground issues, and consequently prices go cautiously. Metropolitans are an uneasy market, with a fall of ¾ on balance; and the rest of the Home Railway market (in steam as well as in electric stocks) is quiet, waiting upon the appetite of the public.

Telegraphs are good all round. Substantial advances stand out in the leading groups. The largest rise is one of £3 in Indo-Europeans. Cuba Submarines are 15s. to the good. In several cases, weeks have elapsed since stock or shares changed hands, but buyers are eager, and have the right to see that prices are put up if they bid, unsuccessfully, the higher of the double quotations. Globes strengthened to 12½. Callenders are 5s. better at 13½; although other cable shares are nominally unchanged as to prices, they are sold much more easily than bought. The Marconi division is quiet, attracting no particular interest at the moment.

General Electric preference moved up ½. British Westinghouse preference eased off to 2 7/16 on the disappointment that the dividend was not raised. The accounts are good, but the board has adopted a cautious policy in regard to the dividend. The Rubber share market is rather less active than of late, operators keeping a wary eye upon Excess Profits possibilities to be announced next week. Armament shares receive a good deal of support, while the shares of base-metal companies remain steady and quiet.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1915.	Dividend 1916	Price April 24, 1917.	Rise or fall this week.	Yield p.c.
Home Electricity Companies.					
Brompton Ordinary	10	9	6¼xd	—	£6 18 6
Charing Cross Ordinary	5	5	3 7/16	+ 1/16	7 5 6
do. do. do. 4½ Pref.	4½	4½	8½	+ 1/16	6 18 6
Chelsea	4	3	2½	—	5 4 4
City of London	8	8	11⅜	+ ⅛	6 19 2
do. do. 6 per cent. Pref.	6	6	9½	—	6 3 1
County of London	7	7	10½	+ ⅛	6 16 6
do. 6 per cent. Pref.	6	6	9½	—	6 3 1
Kensington Ordinary	7	10	5½	—	5 11 7
London Electric	3	3	1	—	Nil
do. do. 6 per cent. Pref.	6	4	8⅜	—	5 6 8
Metropolitan	3	3	2 7/16	—	6 3 1
do. 4½ per cent. Pref.	4½	4½	8½	—	7 4 0
St. James' and Pall Mall	8	8	6½	+ ⅛	6 8 0
South London	5	5	2⅝	—	7 5 6
South Metropolitan Pref.	7	7	2 1/-	—	6 13 4
Westminster Ordinary	7	7	5⅜	—	6 5 9
Telegraphs and Telephones.					
Anglo-Am. Tel. Pref.	6	6	95	+ ½	6 6 2
do. Def.	83 6	1½	29½	+ ¼	6 14 10
Chile Telephone	8	8	7	—	5 14 4
Cuba Sub. Ord.	5	5	8½	+ 3/8	5 17 8
Eastern Extension	8	8	14	+ ⅛	*5 14 4
Eastern Tel. Ord.	8	8	141½	+ ½	*5 13 1
Globe Tel. and T. Ord.	7	7	12½	+ ¼	*5 14 3
do. Pref.	6	6	10	—	6 0 0
Great Northern Tel.	22	23	88	+1	5 15 9
Indo-European	13	13	51½	+3	5 4 3
Marconi	10	10	9⅝	—	3 9 7
New York Tel. 4½	4½	4½	101	—	4 9 0
Oriental Telephone Ord.	10	10	9½	—	4 14 1
United R. Plate Tel.	8	8	6⅝	—	*6 0 9
West India and Pan.	6d.	6d.	1	+ ⅛	2 10 0
Western Telegraph	8	8	14	+ ⅛	*5 14 4
Home Rails.					
Central London, Ord. Assented	4	4	80½	—	5 8 0
Metropolitan	1	1	24	— ⅜	4 3 4
do. District	Nil	Nil	16½	—	Nil
Underground Electric Ordinary	Nil	Nil	1⅜	—	Nil
do. do. "A"	Nil	Nil	5/-	—	Nil
do. do. Income	6	5	81½	—	*6 2 8
Foreign Trams, &c.	Dividend 1914.	Dividend 1915.			
Adelaide Sup. 6 per cent. Pref.	6	6	5	—	6 0 0
Anglo-Arg. Trams, First Pref.	5½	5½	3½	—	8 16 0
do. 2nd Pref.	5½	5½	2⅝	—	—
do. 5 Deb.	5	5	66½	—	7 10 5
Brazil Tractions	4	4	41½	—6	Nil
Bombay Electric Pref.	6	6	10	—	6 0 0
British Columbia Elec. Rly. Pfce.	5	5	61	—	8 4 0
do. do. Preferred	—	Nil	46	—	Nil
do. do. Deferred	—	Nil	30½	—	Nil
do. do. Deb.	4½	4½	63a	—	6 13 10
Mexico Trams 5 per cent. Bonds	—	Nil	26½	—	Nil
do. 6 per cent. Bonds	—	Nil	26	—	Nil
Mexican Light Common	Nil	Nil	12½	—	Nil
do. Pref.	Nil	Nil	—	—	Nil
do. 1st Bonds	Nil	Nil	80	+2½	—
Manufacturing Companies.					
Babcock & Wilcox	14	15	25	—	5 4 4
British Aluminium Ord.	5	7	27/3	—	7 6 10
British Insulated Ord.	15	17½	192	—	6 17 3
British Westinghouse Pref.	7½	7½	2 1/16	— 1/16	6 3 0
Callenders	15	20	18½	+ ½	7 11 0
do. 5 Pref.	5	5	4	—	6 5 0
Castner-Kellner	20	22	3 5/16	—	6 13 0
Edison & Swan, £8 paid	Nil	—	1/16	—	Nil
do. do. fully paid	Nil	—	1⅛	—	Nil
do. do. 4 per cent. Deb.	4	4	69½	—	5 15 2
Electric Construction	6	7½	1	—	7 10 0
Gen. Elec. Pref.	6	6	92	+ ½	6 3 1
do. Ord.	10	10	14½	—	6 18 0
Henley	20	25	15½	—	8 1 3
do. 4½ Pref.	4½	4½	4	—	5 12 6
India-Rubber	10	10	11⅜	—	*8 8 4
Telegraph Con	20	20	87	—	*6 9 10

* Dividends paid free of income-tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

Wednesday, April 25th.

	CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a	Acid, Oxalic	per lb.	1/6	..
a	Ammoniac Sal	per ton	£75	..
a	Ammonia, Muriate (large crystal)	"	£54	..
a	Bisulphide of Carbon	"	£23	..
a	Borax	"	£38	..
a	Copper Sulphate	"	£61 10	..
a	Potash, Chlorate	per lb.	2/6	..
a	" Perchlorate	"	2/-	..
a	Shellac	per cwt.	205/-	10/- inc.
a	Sulphate of Magnesia	per ton	£16	..
a	Sulphur, Sublimed Flowers	"	£32	..
a	" Lump	"	£23	..
a	Soda, Chlorate	per lb.	1/-	..
a	" Crystals	per ton	120/-	..
a	Sodium Bichromate, casks	per lb.	..	..
	METALS, &c.			
c	Brass (rolled metal 2" to 12" basis)	per lb.	..	..
c	" Tubes (solid drawn)	"	..	..
c	" Wire, basis	"	..	..
c	Copper Tubes (solid drawn)	"	1/8½ to 1/9½	½d. dec.
g	" Bars (best selected)	per ton	£168	£6 dec.
g	" Sheet	"	£168	£6 dec.
g	" Rod	"	£168	£6 dec.
d	" (Electrolytic) Bars	"	£145	£6 dec.
d	" " Sheets	"	£170	£4 dec.
d	" " Wire Rods	"	£153	£6 dec.
d	" " H.C. Wire	per lb.	1/6 7/16	1/16d. dec.
f	Ebonite Rod	"	3/-	..
f	" Sheet	"	2/6	..
n	German Silver Wire	"	2/3	..
h	Gutta-percha, fine	"	6/10	..
h	India-rubber, Para fine	"	3/0½	1½d. dec.
i	Iron Pig (Cleveland warrants)	per ton	Nom.	..
l	" Wire, galv. No. 8, P.O. qual.	"	£40	£2 inc.
g	Lead, English Pig	"	..	..
g	Mercury	per bot.	Nom.	..
e	Mica (in original cases) small	per lb.	6d. to 8/-	..
e	" " " medium	"	8/6 to 6/-	..
e	" " " large	"	7/6 to 14/- & up.	..
d	Silicium Bronze Wire	per lb.	1/9½	½d. dec.
r	Steel, Magnet, in bars	per ton	..	..
g	Tin, Block (English)	"	..	..
n	" Wire, Nos. 1 to 16	per lb.	3/3	..

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
n P. Ormiston & Sons.
r W. F. Dennis & Co.

Electric Dust Vans at Dover.—The March issue of the *Electric Vehicle*, in addition to a number of interesting articles on the subject of the battery-driven vehicle, contains a useful index to Vol. I (December, 1914, to December, 1916). One of the articles, referring to the subject of our headline, contains data recently presented by Mr. R. H. Crummack, the deputy borough engineer of Dover, to his Council, dealing with 15 months' use of such vehicles. He points out that extra house refuse, averaging 45 tons per week over the amount of the previous year, was dealt with, and that in the days of horse haulage this would have necessitated the employment of five additional horses and carts at an extra cost of £910 per year—an expense saved by using the "Electric." Five 2½-ton vans were employed, the last for only seven months of the fifteen. The total mileage was 28,825; annual mileage, 23,000; and total quantity of refuse collected, 12,741 tons. The monetary cost of the work, including wages, wages of man at tip and rent of two tips, repairs, &c., stores, tires, capital charges, electrical energy, and insurance, was £2,441 11s.; neglecting tip expenses, the operating cost was 19·4d. per mile, electrical energy at 1½d. per unit averaging 2·32d. per mile. The total cost per ton of refuse collected was 3s. 9·98d., which contrasts strikingly with the previous cost by horses and carts—6s. 2d. per ton. The cost per mile, excluding wages and capital charges, was 4·25d.

Luncheon.—The British Empire Producers' Organisation held a luncheon meeting yesterday at the Savoy Hotel, when the guests were the Right Hon. Walter Long, M.P., Colonial Secretary, and the Right Hon. Robt. Rodgers, Canadian Minister of Public Works.

Catalogues Wanted.—A correspondent on National Service requires catalogues (with prices) of lamps, motors, arc lamps, accessories, fuses, &c. They may be forwarded to us, marked "O.P." on cover.

Training in Science.—As a permanent memorial to the North Wales men who have given their lives in the war, new science buildings are to be erected at the University College of North Wales.

THE IMPORTANCE OF CANAL DEVELOPMENT TO THE ELECTRICAL MAN.

By W. T. WARDALE, A.M.I.E.E.

The Electrical Review has been a consistent supporter of the development of our inland waterways, and has pointed out on numerous occasions the benefits which would follow to the trade of the country in general, and the electrical engineering trade in particular, if such development was taken in hand in a thorough and comprehensive manner.

Few electrical men, however, seem to give the matter much thought beyond the realms of the cheaper carriage which might then be available, and the work which would fall to the electrical trade as the result of some of the canals being worked electrically. The correct development of the canals means the electrification of the canals; this in turn means that very considerable facilities will be placed in the hands of those engineers who seek to place the supply of electricity on a really national basis.

It may be argued by some engineers who are lukewarm to this development of our waterways that it would by no means follow that electrical means would be used for the propulsion of the vessels using the canals; that oil-engined and steam-driven tugs, and barges, make really good and satisfactory progress, and that in any case the canal development would be a costly matter for the nation.

Perhaps the latter point should be considered first, that is, the cost.

Granted that the cost of the canal improvements would be heavy, it would still pay the nation to make the development without looking for any actual return in the shape of direct dividends from dues collected from canal traffic.

After the war we shall be busy for a while, and then will come a period of somewhat acute slackness if arrangements are not made to prevent it.

Let the scheme of development for the canals be worked out, and prepared, and then work can be started as soon as the overplus of after-war work shows signs of dying down; let certain portions be taken in hand, and the work be arranged to start so that no trade, and no man, need be idle; this alone would save us millions of pounds as a nation in the relief of distress, and in poor-law charges; and instead of leaving the nation at the end of the slack period with a heavy debt, and a large proportion of men who have been pauperised to an undesirable extent, it would endow us with a superior means of inland transport, and keep the whole of our trades, and the people engaged therein, in the best state of health, which is engendered only by constant activity.

Again, sensible men do not protest against the idea of spending £16,000,000 on about five or six capital ships for our Navy, and the spending of several millions a year on the canals, until they are a really first-class asset to the nation, should be regarded as a protection for and method of developing the national trade, which finds the money to equip our Navy; for certain it is that if we have a declining trade, we must also have, as a natural corollary, a declining system of national defence.

This bugbear of excessive capital cost and no chance of a return on the money is fallacious, to a great extent, when judged in the light of what ordinary commercial concerns are wont to pay for the privilege of gaining access to markets or districts they consider desirable.

Besides the example of the Manchester Ship Canal, there are many other examples of huge expenditures which have been incurred for what may be termed wayleaves through particular areas.

It is urged that the cost of getting a widened and deepened canal through Birmingham, for instance, will be excessive on account of the buying-up of buildings on the banks, and the diversions of railways in the centre of the city.

In the first place, it may be possible to reduce greatly the cost of such a scheme by going wide of the original line of the canal; but in any case, did anyone ever find a railway company flinch at the cost of buying up and pulling down large areas in order to obtain terminal facilities for passengers or goods? The writer can remember the wholesale clearance of the Deansgate area of Manchester when the Great Northern Railway constructed their Manchester goods station, and the very expensive work which followed in order to bring the lines on arches into the chosen position. Then we have the example of the Great Central Railway, buying up and clearing the area to build Marylebone station. In both these cases very great sums were spent in order to obtain facilities in very restricted areas.

Coming to the electrical side of the matter, we find that a good deal of experimental work has taken place in connection with canal traction on the continent; and that present-day knowledge seems to advise the use of a tractor running on the canal bank, having several barges in tow. Further experience may show improvements on this system. Apart from these matters, however, electrical haulage for the canals has one outstanding feature which seems to have escaped notice. Whatever system of electrical haulage be used, it cannot be denied that traction by means of power supplied from a source outside the boat, or apart from the tractor running on the bank, has the great advantage of permitting the greatest possible load of paying cargo to be carried by the whole canal.

Put the motor in the boat itself; then there is no system of power supply which will permit the concentration of so much power in so small a space as that of electricity supplied from a central station. A tug equipped in this manner would be much more powerful for its displacement than any other type, and so could pull an additional number of barges, and still only occupy the same space in the canal as a steam or oil-driven tug of much less power. Hence the canal space is utilised more efficiently.

Take the motor out of the tug, and make the tug into a cargo barge, and we gain additional cargo-carrying capacity for the canal. Use either an oil or steam-driven tractor on the banks, and that tractor must carry its own fuel, its own power generating unit, and also waste space on the canal or canal banks by the fuel having to be carried about to suitable replenishing depôts.

Substitute electrical traction, and we get either a very much lighter tractor, of the same power, running on the canal banks, with reduced cost of operation; or by maintaining the same weight of tractor, we can double the power, and draw practically double the tonnage of paying cargo for equivalent weight on the bank and its track, besides saving considerable time and cargo-carrying capacity by having no necessity to carry fuel about from one part of the canal to another.

If the canals are to be reorganised, they must be reorganised on the best and most efficient basis; that means the greatest carrying capacity for the width and depth of the canals. This can only be obtained by electrical means.

This re-equipment of our canals would help the national electrical power development scheme very considerably. In many places it is impossible to think of placing a comprehensive power distribution scheme because the distances between the industrial areas are large, and the areas in question are small and somewhat scattered; thus, linking-up and interconnection in those areas are in the present circumstances going to cost more than they are worth.

Get the waterways through that district (and waterways, like roads and railways, must traverse barren districts) reorganised, and at once you not only have reason for placing a good-sized power station in the most favourable portion of that district, but you will be compelled to do so in order to equip the canal with the best and most efficient means of haulage.

Assume that it is decided that work will be done on a certain section; the question is at once asked, where can we place the power supply for this portion? The whole route is surveyed, the best site chosen, and lines run for power right to the spot at which work first starts, and the supply to subsequent portions erected as the work of developing the canal proceeds.

Thus, right from the start of the scheme, electricity will be called in to supply power and light for the work of constructing the improved waterways; once the improvement is finished, a good power load will be assured, and, moreover, districts which could not have appealed to manufacturers will then be able to offer cheap power, cheap land, and the advantage of canal wharfages; so adding to the traffic which will use the canal, calling for more and more power, and, with all the development, never spoiling the countryside by works and factories which vomit smoke into the atmosphere each in their own pet fashion.

The national benefits do not stop even at this point. Agriculture is going to benefit by electrical driving of farm and field machinery; but if there is only a 25 to 50-H.P. demand at intervals of every half-mile, or considerably more, then so much cable will be required, that the cost of distribution will come out heavy, and the cost of the unit be high; let the waterways be developed and electrically equipped, and there you get your agricultural supply of electrical power to a considerable number of areas; the open portions of the canal route consist of agricultural land, so that where one cannot get a factory load, it will be possible to work up a good farm load, and to supply the same at a low cost per unit.

It is true that present prices per unit pay the farmer, though they are high for power supply; from this it must not be argued that no need exists to cheapen the supply to these communities. Cheapen the supply, and immediately you will induce the farmer to do more of his work by electrical means; the petrol-driven plough is showing what can be done by machines to hasten and increase output, and we, as electrical men, ought to be ready at the end of the war to offer the farmer cheaper power electrically for the same work, with the added advantage, that the farmer need not bother about bringing petrol or coal from the station, nor about having a man who can humour petrol engines about his premises.

The development of the canals, therefore, is of the utmost importance to every electrical engineer, whether he is a consultant, manufacturer, or power supply engineer. Such development will not only enable the trade of the country to be carried on more efficiently, but will do much to stimulate the revival of agriculture in our own land and to solve the problem of our food supply by getting the utmost efficiency out of the land.

In brief, the writer's summing-up is as follows:—

The canals must have electrical power, light, and other facilities if they are to work at the highest possible efficiency. This demand for electrical power will give an excellent reason for the planting of large economical stations in situations which, without the canal work, would be unsuitable and unremunerative positions.

It will assist the development of the national electrical power supply by (1) giving a power load from the canal itself, (2) taking industries into districts which abut on the canal, but which are not suitable at present for industrial development, (3) giving a cheap supply of electrical energy to the farmer, who will produce more from a given area of land.

These are solid and desirable advantages in every way, and would be truly national developments; they are advantages, be it noted, over and above the advantage of increased transport facilities which the canals themselves would provide.

If the usual British short-sighted view be taken of the matter, canal development may look costly, and not very remunerative. If we will but take a long-sighted survey of the matter, the possibilities are immense, both to the nation and the electrical engineer.

VOLTAGE REGULATION OF ROTARY CONVERTERS.

The paper by Mr. G. A. Juhlin was read and discussed at a meeting of the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, March 13th.

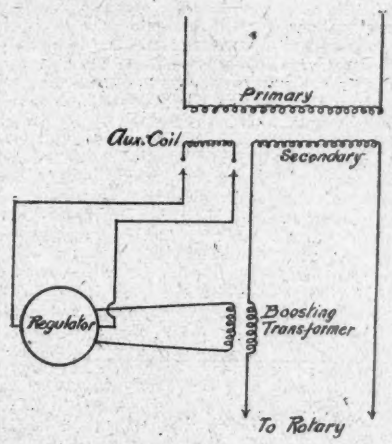
Mr. R. Townend said that the rotary converter was primarily a machine for converting from A.C. to D.C. with as small a voltage variation as possible, and any increase in the voltage range was accompanied by some sacrifice in the heating, efficiency, power factor, or cost of the equipment. If the required voltage range was within the limits permissible with reactance control, this sacrifice might be small, but when the voltage range was outside the limits additional apparatus was necessary, and the sacrifice might be considerable. It was therefore important that the rotary converter should be designed for the voltage range under which it would have to operate, and, with a view to safety, this range should not be increased. With the rotary running inverted, *i.e.*, converting from D.C. to A.C., the conditions were quite different when the rotary was running alone from those obtaining when A.C. generating plant was running in parallel with it. In the former case any variation in the rotary field excitation would only cause a variation in the speed of the machine and would not affect the voltage, therefore some form of auxiliary apparatus was necessary to have control over the A.C. voltage. In the case of the rotary running in parallel with A.C. generating plant, a variation in the excitation of the rotary would not change the speed, because the rotary would have to run synchronously with the other machines, and therefore the change in field current caused a change in the wattless current flowing in the rotary, this change being sufficient practically to neutralise the alteration made in the field excitation. The change in the wattless current would, of course, cause variation in the A.C. voltage provided there was some reactance in the circuit, exactly as in the case of a rotary converting from A.C. to D.C. and having reactance control. This variation in the rotary wattless current simply meant that the wattless current carried by the rotary was now carried by the A.C. generators or *vice versa*, and it was therefore necessary to take care that this did not result in overloading these generators with wattless current.

Prof. Miles Walker said that the paper was so thoroughly sound that it was difficult to find important points to criticise, but there was a looseness in the employment of terms which, however justifiable in shop conversation, ought not to appear in important Institution papers. For instance, the word "reactance" was continually used where "reactance drop" was meant; similarly, "resistance" was used to indicate "resistance drop." Sufficient care had not been taken to make the clock diagram clear. Every clock diagram should be accompanied by a small sketch of connections showing the directions in the circuit taken as positive by the vectors in the clock diagram. Moreover, where different voltages were dealt with in the problem, which varied their phase difference under changing conditions, it should be definitely stated which vector was taken as standard of phase. Non-compliance with these simple precautions made all the clock diagrams in the paper exceedingly difficult to interpret. Moreover, in the first figure the scale of vectors was changed without intimation. The reduction of the wattless current required to produce a given voltage variation, when saturated reactance iron was used, was of great interest; but this gain was only possible where the reactance drop was used in pulling down the voltage when drawing a lagging current. Another fact of note was that where the compounding characteristic was of the kind shown in fig. 4 there was some danger, when a machine was being taken off load, of a sudden slump of load occurring as the load was being reduced, and a heavy reverse current being taken by the rotary before the circuit breaker came out on reverse current.

Mr. J. Frith said that a comparison of the rotary converter with the motor converter should have been considered. In the case of a motor converter, voltage regulation could be

obtained with much less tampering with the power factor. There was certainly a looseness of expression throughout the paper which made it difficult to understand whether currents were lagging or leading to the rotary. The whole matter might have been much simpler if treated from the magnetic standpoint. The word "flux" might have been used instead of "voltage," and would have prevented many false impressions.

Mr. A. G. Ellis said that in deciding the system most suitable for any particular case, the question of reliability in service was important, and in this connection the primary voltage of the system should be taken into account. In high-voltage transformers the introduction of magnetic shunts between the primary and secondary windings in order to increase the reactance, was liable to weaken the transformer from an insulation point of view. Also, for low transformer secondary voltage, *i.e.*, low voltage on the D.C. side of the converter, large sections of copper would be necessary, which would be more susceptible to parasitic losses due to large leakage field. A reactance up to 10 per cent. could generally be obtained as inherent reactance of the transformer without resorting to the use of magnetic shunts of sheet iron placed between the primary and secondary windings, still retaining a rational design as regarded material and efficiency. Above this value magnetic shunts were usually necessary, and a reactance up to 50 per cent. could be obtained by skilful designing with a short-circuit characteristic not deviating appreciably from a straight line. Such high reactance was not usually necessary for the range of voltage variation required in practice. This was fortunate, as the disabilities as



Arrangement Referred to by Mr. Peck.

regarded parasitic losses, space required for the reactive iron, and mechanical rigidity, increased with the reactance. These difficulties were not, however, insuperable, even with very high reactance. A wide range of voltage was practically only required in the case of rotaries working on either lighting or traction load for, say, 440 or 550 volts D.C. In such cases the most satisfactory arrangement was to provide a tap for the lower voltage on the L.T. side of the transformer. This was generally a practicable proposition, although it was not always an easy matter to bring out such a tap, especially when dealing with large currents and high primary voltage. Continental firms had not gone in for high-reactance transformers to such an extent as was usual in England, but had supplied the necessary reactance in the form of a separate choke coil in series with the transformer. This was partly due to the high primary voltage used in Continental systems. Booster transformers, apart from the question of cost, were undesirable on the ground of extra complication, namely, two extra transformers and a voltage regulator. For large rotaries with wide voltage variation limits, a large number of steps on the regulator would be required, or trouble would be experienced on account of the large number of volt-amperes between contacts. This would lead to a large and expensive regulator, and such a fine degree of regulation was not usually required, especially in traction work. The series booster transformers also required special care in construction, as they had to withstand heavy shocks in case of short circuit.

Mr. J. L. Thompson discussed the methods employing static apparatus, namely:—

1. Transformer with internal reactance.
2. Transformer with external reactance.
3. Static boosters and regulators.

For machines transforming power from A.C. to D.C., any one of the three types of static apparatus could be used, but for inverted running alternatives 2 and 3 only could be used. Alternative 1 could not be used on account of the excessive voltage drop, unless the machine was feeding an A.C. system, as outlined by Mr. Townend. The overall efficiency of the static apparatus was about the same for all schemes, although the advantage, if any, lay in favour of that embodying the transformer having high internal reactance. Regarding costs, the following comparison, taking the cost of a transformer of normal reactance as 100 per cent., would be of interest. The transformer was a 550-K.V.A. 3/6-phase, 50-period, with standard adjusting tappings such as used for a 500-K.V.A. rotary converter.

(1) Main transformer	100 %	
(2) 25 % reactance embodied in transformer, extra cost	15 %	
(3) 25 % reactance embodied in an external reactance, extra cost	23 %	
(4) A static booster and regulator to give 7½ % regulation—*i.e.*, the same as would be obtained with 25 % reactance	33 %	45%
Additional switchgear involved, extra cost	12 %	

These rough estimates showed that the high-reactance transformer was by far the most favourable as regarded cost. Floor space was usually very limited, and from this point of view the high-reactance transformer was by far the most economical, while the external reactance was better than the static booster and regulator. If inverted running was required, an external reactance which could be short-circuited, with adjusting taps on the transformer, would be required, or, as an alternative, the static booster. This condition was most favourable for the static booster, and was the only case recommended by the speaker. It was necessary in dealing with a static booster to consider its position with reference to the transformer electrically. When converting from A.C. to D.C., the L.T. side was the correct place, whereas converting D.C. to A.C., the H.T. side was correct, *i.e.*, whichever conversion was used it should be on the secondary side of the main transformer in order to obtain the highest efficiency. A rotary converter feeding a three-wire D.C. circuit with a booster on the L.T. side would require a six-phase booster, this boosting equally each side of the six-phase neutral in order to obtain equal D.C. voltages from the middle wire to the outers. This necessity involved further expense, and depreciated the value of the scheme still further as regards cost. He had designed transformers embodying 45 per cent. reactance, which were working satisfactorily.

Mr. J. S. Peck said that the arrangement shown in the accompanying figure for varying the voltage on a rotary converter by means of a boosting transformer and tappings from an auxiliary coil of the main transformer was actually standardised, and was used on rotary converters up to perhaps 500 or 600 KW.; it was perfectly satisfactory in every respect excepting the regulator dial, which gave trouble, and on account of these difficulties, which were largely mechanical, this type of regulator was finally abandoned in favour of the induction type, which was even now being used to a certain extent, and might again come into general use. It was also possible that the step-by-step regulator might again become popular on account of its cheapness, and improved mechanical construction might make it entirely satisfactory. After the induction regulator came the synchronous booster, due to Prof. Walker. This type of control came into use first in this country, and then in America, and finally on the Continent, and rapidly superseded all other types. When the synchronous booster was first introduced, commutating poles were not generally used on rotary converters, and the difficulties which had since been encountered in connection with booster control had been largely due to the use of the commutating pole, as explained by the author. Designers now hesitated to employ the booster, except when special conditions made its use essential, but devices had been worked out which neutralised the effect of the booster on commutation. These devices, however, introduced complications which it was desirable to avoid whenever possible. Reactance control would give perfectly satisfactory service in many places where previously it was thought that booster control was necessary. With reactance control the power factor of the rotary improved with increase in D.C. voltage, which in general meant that as the load increased, the effect of the rotary was to improve more and more the power factor of the system.

Dr. Cramp (in a communication) said that converters were used not only in connection with sub-station distribution for large districts, but also to supply individual factories; this point of view seemed to have been lost sight of in the paper altogether. The author spoke of wattless current to the extent of 50 per cent. to 60 per cent. of the load current, and omitted to take into consideration the very serious effects of such a condition upon the consumer's account. In many large towns electricity was charged for upon a K.V.A. basis, and in consequence the purchaser had to pay for every ampere of wattless current, whether this was lagging or leading. In such a case the control of power factor was of prime importance, and it often paid to expend more capital to get control of the power factor rather than to use a converter with reactance control. Another point which was omitted altogether from the paper was the loss in the leads between the transformer and the converter. In the case, for instance, of a converter for 500 KW. and 250 D.C. volts, the distance between the transformer and the converter might easily be so great as to lose half per cent., or even more, in efficiency at full load on unity power factor, and this would be considerably increased by the extra wattless current which the author admitted might be as much as 60 per cent. of the load current. For these reasons, the table in the paper was really only a true summary for sub-station conditions. For private plants in general, it was more economical and satis-

factory to adopt either a booster control or a motor converter. With reference to the comparison between the rotary converter and the motor converter, the following figures, which were taken from estimates submitted a short time ago for 500-kw., 460-volt sets, would be of interest. The machines were required to operate at voltages varying from 440 to 480 on the continuous side. Under these conditions the figures were as follows:—

Rotary Converter.

420 volts.

Load	¼	½	¾	1	
Cos ϕ	55	80	90	95	Lagging.

480 volts.

Load	¼	½	¾	1	
Cos ϕ	55	80	90	95	Leading.

As against the above, the motor converter power factor only varied from .93 to unity over the same range of voltage and load. A D.C. booster might be rather more expensive, but it had the merit of leaving the power-factor control untouched, and of not interfering with the commutation of the converter itself.

The Author, in reply, said the paper had been prepared for designers and the average engineer; shop terms were used in the paper as generally understood by engineers. The title of the paper clearly stated that it dealt with rotary converters; if a comparison were made with motor converters, the rotary would certainly justify itself. The treatment of the subject from a magnetic standpoint appeared very attractive, but, in the author's opinion, it would present considerably difficulties; for example, how would a wattless current be represented when there was no change in flux? Transformers of all classes were looked upon as so reliable that all questions of breakdown were of minor importance. There were no grounds for fear on the score of the booster transformer being a source of weakness, and being delicate to control. The costs referred to in the paper were in terms of the rotary converter alone, and did not include the transformer.

FIRST LONDON ENGINEER VOLUNTEERS.

It is seldom that a volunteer corps is fortunate enough to obtain so valuable and enjoyable a training as that of the First London Engineer Volunteers during Easter. The only unpleasant part of it was the severity of the weather, but the work done was of so vigorous and interesting a nature that the men laughed, rather than grumbled, at its inclemency.

A programme of training, admirably adapted alike to the requirements of the Corps and the brevity of the time, was most kindly arranged by Col. Chesney, R.E., the Commandant of the Royal Engineers at Esher, and carried out by Capt. Courtman, R.E., the Commandant of the School of Military Engineering, and Capt. Higgins, R.E. It was felt that in dealing with a corps of this nature, what was required was rather a thorough grounding in technical essentials than any attempt at more ambitious work. The course was, therefore, confined to knots and lashings, the use of spars, trestle bridging, floating bridges, and bridging expedients. So successful, however, was the course that it is not improbable that a more advanced course may be carried out in the future.

It was originally intended that the working party should go into billets at Esher during the four days, but the impossibility of obtaining any accommodation precluded such an arrangement, and necessitated daily travelling to and from Waterloo. In some ways this proved to be an advantage, as certain members were thus able to attend who could not have been absent from town for the whole period. The wretched state of the weather, too, counterbalanced any regret for the absence of camp conditions.

Owing to the uncertainty as to whether Easter would be kept as a holiday, the number attending was not as large as had been hoped. It averaged, roughly, 10 officers and 40 N.C.O.'s and sappers daily. The party left Waterloo each morning about 9 a.m., and returned about 6 p.m.

On reaching Esher on Good Friday, the party marched at once to Sandown House, the headquarters of the School of Military Engineering, and proceeded without delay to the lecture room. Here officers and sappers were cordially greeted by Col. Chesney, and a lecture on the use of spars was given by Capt. Courtman. This over, a three-mile march brought the party to Heywood, where the remainder of the morning was spent in going rapidly through the various knots and lashings. The First London Engineers have received a thorough grounding in these elementary matters, and the work was, therefore, rather a recapitulation than a lesson. After twenty minutes for lunch, three sections were formed for practical instruction in the use of spars. A standing derrick, a swinging derrick, and shears were prepared, and when these were ready the squads were invited to join in hoisting the structures which each had made, and to have their aim and working explained.

For the remaining three days the party was divided into two sections, A and B, whereby the subjects to be dealt with could be taught to and practised by each in turn without overcrowding. The lectures were delivered by Captains Courtman and Higgins, and dealt with trestle bridging, floating bridges, and bridging expedients.

An interesting part of the programme was the construction of barrel piers and rafts, work which came to many of the sappers as a novelty. The enthusiasm with which they "rocked and heaved," although with some it was a physical impossibility to keep one foot on the gunwale, was only equalled by the pride with which they leisurely rowed their ponderous rafts up and down the Mole, oblivious of sarcastic warnings from the shore to "look out for U-boats!" It was a moment of much secret satisfaction to some when they marched in fours on to half a real barrel bridge of their own construction over a real river, and stood thereon to be photographed in perfect safety.

But the real cream of the training was the making of bridging expedients. "A" bridges, hop-pole bridges and pile bridges were interesting, but single barrel-rafts, fascine boats, brushwood boats, and a boat constructed from a canvas horse-trough, with a spar catamaran attached, gave the greatest delight. Those engaged in making these varied expedients for crossing (or falling into) rivers found, when they had finished, that it was the R.E. rule—inexorable, and not to be evaded on any pretext—to "try your own medicine." The training blossomed, therefore, into a veritable regatta, and the Mole was dotted with uncouth craft propelled, with various degrees of skill, by sappers in grey-green, armed with shovels. But nobody fell in or got more than a trifle wet.

The party returned on Monday evening to Waterloo thoroughly satisfied with the work they had done, and feeling that there had never been such a training before.

The Corps owes a very great debt of gratitude not only to Col. Chesney, who arranged for the training, but also to Captains Courtman and Higgins for the way in which it was carried out. To Sergeant-Major Gordon and his body of instructors (all of whom cheerfully gave up their Easter leave for the purpose) also hearty thanks are due. Mention must also be made of the kindness of the Quartermaster of the School of Military Engineering, who arranged tea for the party when work was done.

The training was honoured by several visits by Col. Chesney, on Good Friday by General Dickie and Major Edwards, on Saturday by General Sir Desmond O'Callaghan and Colonel Ormond, and again on Sunday by Major Edwards.

NOVEL FEATURES IN D.C. WATT-HOUR-METER CONSTRUCTION.

Continuous-current meters of the Thomson type are used so extensively, and yet have advanced so little in design during the past quarter of a century, that the improvements described by R. Ziegenberg in a recent issue of the *E.T.Z.* are of especial interest—particularly since the retention of the Thomson type of drum-wound armature has been due simply to lack of a substitute, and not to any high degree of technical excellence in design or performance. The principal features of the new meter here described are the use of a flat coil armature and an electromagnetic connection between meter and counting train. In order to emphasise the advantage of these innovations the author enumerates certain alleged defects of the drum-wound Thomson meter as hitherto constructed. These defects include extreme sensitivity to stray magnetic fields, and serious frictional resistance. By doubling the meter in such manner as to form an astatic system we obtain a very unwieldy instrument, and one which is still far from unaffected by asymmetric stray fields. This expedient, which is at best only partially successful, is only applicable to switchboard or other special meters. For all ordinary work, a single-system meter must be employed, any neighbouring current-carrying conductors must be arranged with special care, and, in most cases, the meter must be adjusted and calibrated *in situ*, since even the earth's field has appreciable effect on the law of the instruments. As regard frictional resistance, Schmiedel's P.T.R. tests on seven commutator motor meters of various makes showed that according to the type of drive employed, friction in the counting train amounted to anything from 7 to 28 per cent., and in one case to 54 per cent. of the total meter friction. These data referred to new meters, higher values for gear friction being observed in meters after some time in service. Add to this the fact that meters with jumping-figure dials may be held stationary on light loads for indefinite periods by the increased frictional resistance to be overcome when two or more dials need moving simultaneously, and it becomes obvious that a counting train which is mechanically independent of the meter represents a very appreciable advance. The sole *raison d'être* of the D.C. watt-hour meter lies in its measuring watt-hours instead of measuring ampere-hours and assuming constant supply voltage. If, however, the advantage gained in the principle of the meter is to be sacrificed to

friction errors and susceptibility to stray fields, one might as well use the simpler and cheaper ampere-hour meter, particularly in small lighting installations where the revenue is low and meter cost a serious item, and where the frequent occurrence of light-load periods renders meter accuracy correspondingly important.

Many attempts have been made to build satisfactory D.C. watt-hour meters of the disk-armature type, the advantages anticipated including immunity from influence by stray fields; light and simple construction; easy access to armature, and possibility of removing and replacing the moving system without disturbing calibration. Sector-shaped armature coils are used, and the armature disk thus built up runs between two pairs of D-shaped field coils (or else above or below one pair of semicircular field coils). The armature and spindle can be withdrawn without moving the field and compensating coils, and since the two halves of the armature lie in fields of opposite polarity the instrument is astatic to a high degree; if a four-pole field system be used (with quadrant-shaped field coils), the meter is almost perfectly astatic, even as regards attempts at fraud by placing a permanent magnet near the armature.

The chief reason why disk-type armatures have not hitherto gained much acceptance in this connection is that sector coils of too small an angle have been employed. Increasing the number of armature coils renders the meter torque more uniform, but it also reduces the actual value of the torque. Current flow in adjacent radial conductors is in opposite directions (save in the case of the radial conductors connected to the commutator bars undergoing commutation at the moment), and when such contra-flow occurs in a single field, the net torque due to the conductors concerned is zero. The way to obtain a high driving torque from a light disk armature of low resistance is to employ wide-angle sectors, and not more than two armature coils per field pole, but preferably fewer. Adjacent radial conductors are then in fields of opposite polarities when they are carrying current in opposite directions or, at the worst, one set of radial wires is in but a weak field of the same polarity (near the neutral zone).

There is no particular mechanical difficulty in the construction of a disk armature, and, though the diameter of the latter be about 50 per cent. greater than that of the alternative drum-wound armature, the construction as a whole is simpler and more compact, and when using an electromechanical recording train, instead of directly geared mechanism, the total saving in spindle length is about 50 per cent. A four-pole field system and six-coil armature represents a satisfactory compromise between simplicity of construction, high driving torque and minimum dead weight, and resistance in peripheral copper (which is ineffective as regards driving torque).

The most obvious method of relieving the meter of the duty of driving the recording train is to use a shunt-

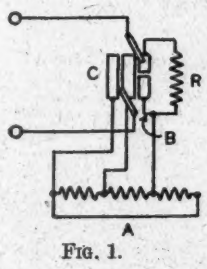


Fig. 1.

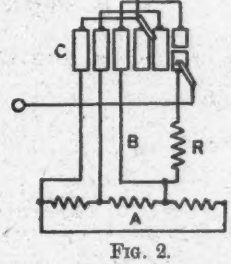


Fig. 2.

wound electromagnet and ratchet gear controlled by a contact on the meter spindle, this contact completing the magnet circuit once in each revolution of the meter spindle. This solution is, however, unsatisfactory, for heavy sparking occurs at the spindle contact, and the use of the latter introduces an element of distinct unreliability into the working of the instrument. It is unnecessary actually to make and break the circuit of the electromagnet. A suitable variation in the exciting current will secure the desired result and, at the same time, eliminate the sparking difficulty. The minimum current may be kept quite small (say, 1 milliamp. or so) and increased to 3 milliamps. or so whenever it is desired to actuate the recording gear. The problem remains—whence to obtain a suitable varying current? Current of varying strength lies ready to hand in the armature circuit, but it cannot be actually diverted to the circuit of the recording magnet without introducing the contact difficulties which it is wished to eliminate. Evershed has devised a system of placing a small coil round the spindle, connecting it in the armature circuit and utilising the alternations of current to oscillate by induction a second winding or a permanent magnet. This arrangement involves keeping the recording gear quite close to the actual meter, whereas the system now to be described permits meter and recording gear to be placed at any convenient points, any distance apart, and connected only by a pair of small leads running to and from the electromagnet, which actuates the recording train by a ratchet arm attached to its armature. Figs. 1 and 2 show the shunt circuits only of a watt-hour meter with three-section armature A and three or six commutator bars C respectively. Fig. 1 corresponds to a two-pole field system, and fig. 2 to a four-pole field system, each armature section in the latter case consisting of two coils opposite to each other on the armature and connected in series.* It will be seen that in both cases one commutator bar is divided at the centre of its length, and the brushes are set so that during each revolution of the armature, connection is completed once through the direct lead B and once through the resistance R. When the latter is in circuit the P.D. across the brushes is increased by the amount IR (I being the armature current), and this pressure increase suffices to actuate the recording magnet, which is connected across the brushes. For convenience and security, the commutator is made rather longer than usual when this arrangement is employed. A central insulating ring is added (primarily to support the inner ends of the divided bar), and one brush bears on the upper and one on the lower half of the commutator.

Meters built on this principle are at present made by the firm of Elster (Berlin and Vienna), but it is hardly necessary to remind readers that arrangements have been made to work enemy patents where such a course seems desirable. The advantages offered by the new construction include simplicity, compactness, immunity from influence by stray fields, light moving system, and a driving torque much higher than obtainable with a greater number of coils of equal weight, and amply sufficient owing to the meter being relieved of the duty of driving the recording train. With the new system of actuating the recording gear (which system is equally applicable to any commutator meter), the meter error is uniformly low at practically all loads. In a particular case, for instance, the error was 4 per cent. at 2 per cent. full load, 1.25 per cent. from 5 per cent. full load to full load, and about 0.6 per cent. at 50 per cent. overload. In switchboard and central-station practice generally it is an important advantage to be able to place meter element and recording train independently wherever desired.

THE WIRING RULES OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

By W. R. RAWLINGS, A.M.I.E.E.

(*Abstract of paper read before the* Association of Supervising Electricians.)

The I.E.E. Rules have been adopted by all the responsible fire offices (51 in number), the whole of the electricity supply authorities worthy of that name, 14 of the London supply companies, and 25 municipal undertakings. The Incorporated Association of Electrical Power Companies, and the Incorporated Municipal Electrical Association representing over 200 municipal authorities, also accept the Wiring Rules as standard practice and recommend their use. The foregoing facts definitely establish that the rules have become the standard rules for electric wiring and fittings throughout the country. There are still a few faddists who issue their own regulations, and do their best to enforce them by trying to belittle the contractor in the eyes of the consumer. The time is, I hope, not far distant when these superfluous rules will be removed, and the Institution Rules will become as binding upon all parties as the rules which govern factories and workshops.

My experience, and the experience of fellow contractors, shows that there is no difficulty in complying with the wishes and requirements of the fire insurance inspectors. The most difficult individual we have to cope with is to be found amongst the supply station engineers, whose training, perhaps, has not enabled him to become a judge of house wiring, but he often endeavours to enforce his ideas by threatening not to connect until his views are carried into effect. That he has no such power has been shown over and over again by Mr. R. Tweedy Smith, the honorary solicitor of the Electrical Contractors' Association.

As one is never anxious to fall into the hands of lawyers the contractor generally submits, if he is not a member of the E.C.A.

I hope the time is not far distant when the I.E.E. Rules will be adopted by the Board of Trade, when they will reign supreme, and thus stop all engineers from abusing their position, and by their improper actions checking the progress of the industry.

*An ingenious method of effecting the connection between diametrically opposite commutator bars in this case (fig. 2) is to form each pair of such bars from a single silver strip bent to U-shape. The limbs of the U form the two contact bars, whilst the end piece forms a perfect and reliable cross connection and, being drilled, serves also for attachment of the commutator elements to the spindle. Insulating disks are placed between the three U-pieces, which are spaced circumferentially equidistant on the spindle in building up a six-bar, three-section commutator.

Perhaps the most important variation which has been made by the recent rules (1916) is the permission to use the Continental system of flexible wires. I cannot, however, learn that this alteration has been adopted to any extent. For my part, I do not think it a desirable method of wiring, except, say, for an office, where flexible wires are fitted to ceiling points over eyes to desired positions, which are subject to variations. The alteration of rules has also made permissible the introduction of new systems, such as the Stannos, Henley's, and also the rubber-compound sheathed wires. I think the Institution can be congratulated on its endeavour to popularise low-priced systems of efficient wiring.

Rule 32 is not always understood, although apparently it reads quite clear:—

"For lighting purposes in any final sub-circuit which supplies more than a single point, the current must not exceed six amperes for pressures up to 125 volts," &c., "and the maximum number of points on any sub-circuit must not exceed 10."

This clearly defines the question often raised—how can a lamp which takes more than six amperes be used? The answer is that if it does exceed six amperes you can only put one on a circuit. If a lamp takes 50 amperes it complies with the rule, so long as you do not put more than one on a circuit. The number of points also which can be fixed on one circuit has been clearly defined as not to exceed 10. This is a good rule, and should be better known.

Conductors. Rules 39—43.—To my mind the finest work done by the Institution in the rules is the course taken in dealing with conductors.

The only thing, except a drop in volts, which governs the size of a conductor is the heating effect, and on reference to the Institution rules you will find that the table is based on a rise in temperature of 20 deg. F. above the air. Whereas a No. 18 gauge wire was considered unsafe in the old days, if used for more than 1.8 amperes, the Institution rule allows 7.2 amperes, while a cable of 1 sq. in. area, which in the old days would be used for a thousand amperes, is limited by the Institution rules to not more than 595 amperes. I would, however, caution my hearers against the adoption of the table without carefully reading rule 40, which governs the permissible drop in volts. Rule 40 provides that for lighting the drop "must not exceed 2 per cent. plus a constant allowance of one volt," but as many of the fuses will bring about a loss of half a volt, my advice is to allow the one volt constant to be absorbed in fuses, switches, &c., leaving the 2 per cent. for the wires, which will work out with a sufficient margin in dealing with a complete installation. This rule altering the size of the conductors has done much to popularise heating installations, for whereas a pair of 7/18 cables had to be installed for a 1-kw. 100-volt radiator, the same piece of apparatus can be used, under the new rules, with a 7/24 cable, bringing about a considerable reduction in the cost, and the difficulties of installation. A drop of volts in the cable is not an important factor when dealing with heating circuits.

Earthed Concentric Wiring. Rules 76—78.—I am of opinion that electrical contractors do not realise the advantages of earthed return systems. I find that new private plant installations are still being laid down on the two-wire system. There is no doubt that concentric earthed systems are not only more secure, but also the initial cost of the installation is considerably reduced. A complete draw-through job can be obtained by adopting the Kalkos system, using the tube as the return, or even extended to form a three-wire system. If a solid system is preferred, one of the metacase systems could be adopted. I advise my hearers to devote attention to this subject, which, without doubt, has been the means of introducing electricity into many country mansions, which would not have been wired had steel tubes or casings only been available for use.

Fuses. Rules 98—99.—It will be noted that the rule allows a very large margin. Small fuses may be three times the area required for the working current, and for circuits over 10 amperes twice the area is allowed.

Motors. Rule 122.—This rule as to double-pole switching, &c., only applies where the machine exceeds one-third of a horse-power. This is a most useful concession, as it permits of domestic apparatus being used on ordinary lighting circuits.

Rules for the Use of Electric Light on board Vessels.—The last edition of the rules was registered in December, 1914, at Lloyds. I am pleased to state that there is at the present moment an influential and strong committee of the Institution framing special rules for the electrical equipment of ships.

National Insurance (Unemployment) Acts, 1911 to 1916.—Contributions are payable in respect of:—

2,178 X. Workmen employed on metal work in connection with the manufacture of X-ray and electro-medical apparatus.

2.179 X. Workmen (other than those insurable under Part II of the National Insurance Act, 1911) engaged wholly or mainly in making (removable) lamps for buoys or beacons.

Contributions are not payable in respect of:—

2,180. Workmen described as rest room attendants, and engaged in looking after workers, keeping rest room clean, &c.

NEW PATENTS APPLIED FOR, 1917.

(NOT YET PUBLISHED).

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford.

4,980. "Sparking plug." R. Taylor. April 10th.

4,993. "Demagnetiser for continuous or alternating currents." A. Hollingworth. April 10th.

5,005. "Electrical current or voltage regulator," R. W. M. Thomson. April 10th.

5,009. "Controlling current in connection with electro-magnetic gear-boxes of automobiles." T. Wardell & Wolseley Motors, Ltd. April 10th.

5,018. "Telephone transmitters, &c." A. Marr. April 10th.

5,054. "Magnetic separators." W. G. Fletcher & A. F. Hallimond. April 10th.

5,067. "Telegraphic receiving and tape-perforating apparatus." A. C. Huskinson, A. L. Muirhead and Muirhead & Co. April 10th.

5,072. "Electrically-heated resistance furnaces." H. Etchells & H. A. Greaves. April 11th.

5,073. "Alternating-current electric systems." A. E. McColl. April 11th.

5,088. "Electric switchboards." C. C. Garrard & A. H. Railing. April 11th.

5,112. "Housing of electrical switchgear." A. H. Curtis & Igranic Electric Co. April 11th.

5,151. "Electric welding apparatus." W. H. Isherwood & W. H. Turner. April 12th.

5,168. "Systems of control for single-phase commutator motors." British Westinghouse Electric & Manufacturing Co. (U.S.A., April 12th, 1916.) April 12th.

5,177. "Electrically depositing metal." E. H. Jones. April 12th.

5,178. "Electric machines." H. Chitty. April 12th.

5,196. "Reversing devices for internal-combustion engines with electrical ignition." A. G. Hallberg. April 12th.

5,214. "Sparking plugs for internal-combustion engines." J. C. de Hordt. April 13th.

5,220. "Electric welding." W. H. Walker. April 13th. (U.S.A., April 14th, 1916.)

5,224. "Telephone meters." G. I. Bruschke. April 13th.

5,246. "Tanks for electrical transformers." A. Schaanning & J. L. Thompson. April 13th.

5,252. "Variable inductances." A. H. Bagnold, F. G. Goldstone & S. Johnson. April 13th.

5,254. "Electric current interrupters." K. Trosdahl. April 13th.

5,260. "Electrodes for electric arc soldering." E. H. Jones. April 13th.

5,267. "Ignition current generators." L. J. le Pontois. April 13th.

5,281. "Electric submarine destroyer." F. A. Hirst. April 14th.

5,282. "Mouthpiece for telephones." W. R. Walkey. April 14th.

5,292. "Electric regulators." British Thomson-Houston Co. (General Electric Co., U.S.A.) April 14th.

5,295. "Insulation of submarine telephone cables." Felten & Guilleaume Carlswerke Akt. Ges. April 14th. (Germany, April 14th, 1916.)

5,301. "Control of dynamo-electric generators." British Westinghouse Electric & Manufacturing Co. (Westinghouse Electric & Manufacturing Co., U.S.A.). April 14th.

5,305. "Insulating devices." E. T. Brook & W. E. Windsor-Richards. April 14th.

PUBLISHED SPECIFICATIONS.

1916.

The numbers in parentheses are those under which the specification will be printed and abridged, and all subsequent proceedings will be taken.

3,737. Automatic and Semi-automatic Telephone Systems. Relay Automatic Telephone Co. & H. J. Herink. March 13th, 1916. (Cognate application, 12,971/16.) (104,892.)

4,049. Casings for Electric Batteries. A. H. Shepherd & British Ever-Ready Co. March 18th, 1916. (104,900.)

4,143. Searchlights and like apparatus. A. A. Lyon. March 20th, 1916. (104,907.)

4,184. Electrical Distributing System depending on the use of Condensers. H. G. Longford, W. W. Longford, W. A. Clark & T. Morris. March 21st, 1916. (104,909.)

4,196. Means for Indicating the State of Adjustment or Output of Dynamo-electric Machines. J. Stone & Co. (Rohman, H. D.). March 21st, 1916. (104,910.)

4,376. Maximum Indicators for Electricity Speed and other Registering Apparatus. Chamberlain & Hookham and S. James. March 24th, 1916. (104,924.)

4,467. Interrupters or Contact Make-and-break Mechanism for Magnetos. A. Guedatarian. March 25th, 1916. (104,931.)

6,720. Mechanical Tee-joint for Multicore Electric Cables. A. J. Lovell. May 11th, 1916. (104,959.)

6,823. Automatic Machine for the Manufacture of Stems for Metallic Filament Electric Lamps. Morris & Whitham and J. A. Allison. May 12th, 1916. (104,962.)

8,128. Electric Motor Control Systems. British Thomson-Houston Co. (General Electric Co., U.S.A.). June 8th, 1916. (104,979.)

10,142. Pendulum Indicators for use with Electric Bell Systems or for other purposes. I. H. Parsons. July 19th, 1916. (105,004.)

11,125. System of Electrical Distribution. W. H. Cole. August 12th, 1915. (101,151.)

11,191. Electric Motor Control Systems. Igranic Electric Co. (Cutler-Hammer Manufacturing Co., U.S.A.). August 8th, 1916. (105,013.)

12,999. Telephone Appliance. F. Mayer & W. C. Croxon. September 13th, 1916. (105,028.)

13,585. Means for Carrying Electric Cables. A. Detraux. March 23rd, 1916. (Divided application on 4,353/16.) (105,029.)

14,524. Apparatus for Electrically Sterilising Foods. J. Hansen. October 12th, 1915. (101,804.)

17,923. Electric Pocket Lamps. O. Pletscher. November 18th, 1916. (105,046.)

1917.

449. Stators of Electric Generators. J. Bethenod & E. Girardeau. August 10th, 1915. (Divided application on 10,576/16.) (103,858.)